NATURE

No. 4194 SATURDAY, MARCH 18, 1950 Vol. 165

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Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831
Telegrams: Phusis Lesquare London

Advertisements only should be addressed to:
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Telephone Number: Temple Bar 1942

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THE CHEMICAL INDUSTRY AND ITS DEVELOPMENT

THE comprehensive survey of the British chemical industry, prepared by the Association of British Chemical Manufacturers, in co-operation with other related associations, at the request of the President of the Board of Trade, is of wide and general interest; a summary of the principal features appears elsewhere in this issue (p. 420). The report claims to be the first comprehensive survey of the industry—its history and origins, its disposition and present activities and its plans for to-morrow—which has yet been published. It endeavours not only to give a clear picture of the industry itself but also of its relations with other industries, and to indicate the place it occupies as a supplier both of basic raw materials, such as soda ash and sulphuric acid, and highly finished products, such as penicillin. Quantitatively, the omission of details of expansion schemes (regarded as confidential to the Board of Trade) makes it difficult for the reader to judge how far particular sections of the industry are likely to be adequate to the part they have to play in the national economy. On the adequacy of the plans of the industry as a whole, the report leaves no doubt, and the picture of this highly complex, dynamic industry, demanding the utmost freedom of enterprise, and scientific and technical skill on a scale surpassed in no other industry, is as impressive as it is timely when the future structure of the industry of Britain is coming under political scrutiny.

The very difficulty of defining the extent of the chemical industry—the compounding of chemicals to make such products as paints, insecticides, sheep- and cattle-dips, and pharmaceutical preparations, and synthetic fibres and rayon are excluded, as is, by agreement, the tar distillation industry as such, which is to be studied by the Ministry of Fuel and Power—attests the complexity of the industry and its sensitivity to the development of new products or new routes to existing products, and the far-reaching consequences which may issue from such developments. To a limited extent this is indicated by the brief chapter on the achievements of the industry; but much is left to the imagination if one is to appreciate the full extent of the war-time achievements of the industry. Here, however, welcome emphasis is laid on the attention which the industry has given to the development of new uses for its products, and the benefits that have thereby been conferred on other industries.

The point is important, because it is by no means generally realized how development is handicapped by the preoccupation of consumers with their own difficulties, and their consequent inability to co-operate fully in assessing the value of a new product. This is a main factor obstructing the attempt of British chemical industry since the War to reduce the gap in time between discovery and its commercial application, and it is not always given full weight in discussions on that theme. Shortages of constructional materials and equipment and of technically trained staff, as well as of raw materials,

ncluding chemicals themselves, and delays arising from procedure for getting the necessary licences and permits, are other factors which hamper the industry.

On such matters the report is restrained and objective; but it seems very clear that the decisive factors may be indeed outside the orbit of the Committee on Industrial Productivity, and that Committee or the Advisory Council on Scientific Policy may be obliged to make recommendations impinging on the field of fiscal policy if outside assistance is to be given to the industry and those it immediately serves to decrease the time-gap between discovery and commercial application as compared with the corresponding gap in the United States. Elsewhere in the report the hope is expressed that plans are in operation, or at least in formulation, for eliminating all controls and permit systems no longer essential and for simplifying the machinery for applying those that remain. This is in relation to difficulties experienced in the completion and operation of the new schemes; but although the cost of replacement and extension of plant is discussed in some detail, there is no reference to taxation allowances for obsolescence, or to the suggestion sometimes canvassed that a change in fiscal policy and the basis of taxation policy would be beneficial to industrial development.

In a report dealing with an industry investing so heavily in, and so largely dependent on, research, this seems a significant omission, more especially because the report, while avoiding political issues or arguments, appears to lay much stress on the maintenance of a 'climate' favourable to enterprise and initiative and seeks to indicate the factors which promote them. It recognizes that some of the influences retarding development may be expected to disappear in time, but stresses the need for prompt authorization of new facilities for research and development, and for the granting of licences for the import of indispensable materials and equipment where these are not immediately available in Great Britain. In this connexion again, it is urged that there is a limit to the extent to which a chemical manufacturer can 'make do and mend', particularly because many plants were perforce allowed during the War to fall behind the stage of efficient maintenance. Furthermore, government departments sometimes fail to appreciate the importance of adequate facilities for maintenance.

Equally, if not more, serious than the effect on the efficiency of existing processes of the deferment of schemes for increasing research and development facilities is the long-term effect on new research and development. Time lost on research may never be regained, and the industry has already a considerable leeway to make up compared with the American manufacturer. Government departments have also discouraged the provision of additional office accommodation and amenities, even when these are essential for additional staff and work-people for the design, building, operation and control of increased production, and even when existing facilities have been condemned by His Majesty's factory inspectors. That bears particularly on another difficulty—the present scarcity of scientifically and technically trained staff. While local shortages of labour are not in general a serious problem for the industry, the scarcity of scientific and technical man-power affects every aspect of the industry's activities, and development schemes have been held up on this account and the progress of others retarded. It is the more important, therefore, that lack of office or laboratory accommodation, housing or amenities should not be allowed to hinder the most effective use being made of the services of those who are available.

There is nothing in the report to suggest that conditions in the industry are such as in any way to deter the young scientific worker or technician from entering the chemical industry. The reluctance on the part of university graduates to enter industry, to which Sir Lawrence Bragg directed attention at a British Association Conference on Science in Industry in 1945, finds no mention in this report, and the whole content of the chapter on staff and labour relations suggests that the industry has given close attention to ensuring conditions of service that attract the men it needs and, by affording them the fullest opportunity for self-expression, encourages them to give of their best. No industry recognizes more clearly that the well-being and co-operation of staff and workers are essential elements in the successful and efficient administration of complex modern industrial undertakings.

The figures relating to scientific staff are not quite complete so far as the expansion plans are concerned; hence it is not possible from this report alone to judge the full extent of the demand of the industry upon the trained man-power and woman-power of Britain. It is mainly a demand for man-power, only 253 out of a total of 6,176 scientific staff being women. The magnitude of the future demand is assessed for chemists only. On the basis of replies to a questionnaire in the autumn of 1948, about six thousand chemists were then employed for all purposes, and this was expected to increase to 8,400 by 1953, a figure demanding rather more than one-third of the total estimated by the Sub-Committee of Lord Hankey's Technical Personnel Committee as necessary to replace wastage and provide for expansion in all industry over the next five years, and one-fourth of the total demand for industry, teaching and the public service.

It should be remembered, of course, that although in some other categories of men of science the numbers involved are smaller, a shortage in them may be even more acute and have a wholly disproportionate effect on the industry. Nevertheless, the report sees no substantial advantage to be gained by co-operative research, except perhaps in connexion with chemical engineering. The industry looks rather to the fundamental work bearing on its problems continually in progress at every university and technical institution; and the report emphasizes that the industry does not lend itself to the arrangement of the research association, by reason of the number and diversity of its products and the specialization of its processes. In this connexion it is significant that the larger firms in the industry have themselves a number of research stations dealing with different branches of their

activities, and clearly find it less effective to conduct their research in one central organisation. Certain sections of the industry having common problems that can be conveniently investigated by co-operative effort have, nevertheless, set up, or are organising, research associations: for example, the Coal Tar Research Association and the Paint Research Association; and firms in the industry commonly support the research associations of those industries that use its products.

Apart from this, there is no real guide in the present report as to the fundamental attitude of the industry to the research association principle in general, or whether sponsored research schemes of the pattern of those of the Mellon Institute, or the Fulmer Institute recently established in Britain, offer any advantage in the present man-power situation. There is, according to the present report, no evidence of wasteful overlap in research in the industry in the absence of a research association; and, on the contrary, it is held that some overlap is desirable, since it may lead to a healthy rivalry which acts as a stimulus to progress. It seems, therefore, that although the chemical industry sees no advantage for itself from a comprehensive research association and derives minor direct advantages from those of the industries using its products, it is not seriously concerned with the proportion of Great Britain's scientific man-power now engaged in the research associations, in spite of its own difficulties in recruiting all the scientific men and technologists it requires for expansion. Similarly, in the absence of any positive suggestions like those which Dr. W. H. Garrett recently made to the University of Liverpool Chemical Society, for improving the liaison between the universities and industry, it seems a legitimate inference that the chemical industry is reasonably satisfied with the present arrangements. Full use, moreover, is made of the research establishments of the Department of Scientific and Industrial Research, and it would seem that the chemical industry is reasonably satisfied with the general organisation of the country for scientific research.

Besides the complexity of the industry and its dependence, not only upon research, but also upon initiative and the ability to recognize and use the opportunities offered by the advance of science and technology and the constantly changing situation in regard to raw materials and the application of its products, there is one other feature that is particularly stressed in this report. Attention is directed in several places to the high cost of replacement of plant, which now amounts to about two and a half times the original cost in 1939. It follows that, besides the high proportion of scientific and technical staff to other workers, the industry is characterized by high capital investment, amounting to about £231 millions, which in terms of to-day's costs probably represents £400 millions. The schemes of replacement and expansion, to two-thirds of which the industry has already committed itself, call for roughly another £200 millions.

The need for specialized and costly plant is one of the three main reasons why economic monopolies are claimed to be an essential feature of efficient operation by the industry. The small demand for certain chemicals is another, and the technical knowledge and experience essential for some processes a third reason why many products, not protected by patent, are made exclusively or predominantly by a single firm, which may be, and frequently is, a small one. The cost of plant, and the technical control needed to obtain high yields, may make the effective operation of a process only possible if it is carried out on the largest scale justified by the demand for the product. Monopoly may be unavoidable if the scale of production adequate to achieve low production costs, and consequently the lowest selling prices, is to be secured.

One reason why the chemical industry welcomes the Monopolies and Restrictive Practices Act is the protection the Act will afford the industry against misinformed and ill-considered criticism for maintaining monopolies of this type. The report, however, points out that there is, even in these monopolies, a certain amount of protection for the general public which is inherent in the nature of the industry itself. First, the dynamic character of the industry and the extreme diversity of its products and of the choice of materials that it provides for the user industries ensure the existence of competition and provide a safeguard against abuse, quite apart from the ever-present risk of a dramatic transformation in the whole situation as a result of some new discovery. No chemical manufacturer could ever safely base his business on the retention of a 'monopoly' in certain products. The slightest suspicion of abuse of a monopoly in the industry would clearly stimulate research leading to the production of substitutes or alternatives which might well completely displace the 'monopoly'. So keenly are manufacturers aware of this that, both to avoid criticism and to deter competition, they will tend to work on narrow profit-margins and thus run less risk of attracting other manufacturers to the field. Further, where heavy capital expenditure has been incurred, the need to operate the plant to full capacity in order to secure a reasonable return upon the capital investment also tends to induce the manufacturer to stimulate demand by fixing low selling prices.

It is obvious that in this admirable report no pains have been spared to depict, accurately and faithfully, not merely the structure and achievements of the industry and its plans for the future, but also to display lucidly and frankly the conditions for the efficient operation of the industry and the factors which have determined both its present organisation and success. There can be no doubt about the immense contribution which the chemical industry can make to the economic future of Great Britain, or about the complexity and ramifications of the issues which are involved in any attempt at State control. The Association of British Chemical Manufacturers and those who co-operated in the survey on which the report is based are to be congratulated on the extent to which they have succeeded in providing the objective appreciation from which any reasonable discussion of the future of the industry must start.

STRUCTURE–ACTION RELATIONSHIPS OF DRUGS

Structure et activité pharmacodynamique des médicaments du système nerveux végétatif

Adrénaline, acétylcholine, histamine et leurs antagonistes. Par D. Bovet et F. Bovet-Nitti. Pp. 849. (Bale: S. Karger S.A., 1948.) 85 Swiss francs.

RELATIONS between the chemical constitution and the physiological action of drugs have fascinated and baffled organic chemists and pharmacologists ever since the classical work of Crum Brown and Fraser. Some authors have despaired of finding any firm relationships; thus A. J. Clark wrote: "It may be said that there are scarcely any general rules discernible and that every cell-drug system appears to be a law unto itself". On *a priori* grounds a particularly promising field for the study of structure–action relationships should be that in which drugs impinge on physiological functions which are controlled by the liberation of the relatively simple substances, acetylcholine and adrenaline, to which *nor*adrenaline must now be added; this is the field of study to which Dr. and Mme. Bovet have devoted themselves.

Their book deals with drugs which imitate or antagonize the effects of (1) adrenaline or stimulation of adrenergic nerves, (2) acetylcholine or stimulation of cholinergic nerves and (3) histamine; the physiological functions of histamine are more obscure than those of the other two substances, but its liberation from cells produces dramatic effects, for the treatment of which a new group of substances has recently been discovered. The authors have themselves added greatly to our knowledge of several groups of drugs with which they deal, particularly drugs which antagonize adrenaline, curare-like drugs and anti-histamine drugs; indeed, they seem to have had an uncanny instinct for the type of molecule which would achieve the effect they desired, and it is fascinating to trace the history of some of their achievements, for example, their development of anti-histamine drugs from compounds originally designed as antagonists of adrenaline.

The book has the rare virtue that its authors are thoroughly familiar with both the chemical and the pharmacological aspects of their subject. All too frequently structure–action relationships have been discussed by chemists who were unable to examine the pharmacological evidence critically, or by pharmacologists to whom organic chemistry was a closed book. The subject demands the closest collaboration between chemist and pharmacologist, and in recalling the history of its development several fortunate examples of collaboration leap to mind: Crum Brown and Fraser, Hunt and Renshaw, Barger and Dale, to mention only older workers in the fields with which the Bovets deal.

Another valuable feature of the book is the emphasis given to quantitative data, most of it given in tables and some of it illustrated by reproductions of kymograph tracings. The only regret that the reviewer had on laying down the book was that problems of mechanism had scarcely been mentioned. A tremendous wealth of information is presented, but, apart from a few tentative generalizations relating structure to action, this rich storehouse of factual evidence is not used as a basis for discussing how so many and varied compounds can achieve similar physiological effects.

A simple example may illustrate the point. Adrenaline is a hormone and almost certainly a chemical transmitter at some autonomic nerve endings; it has both acidic and basic properties, but many of its effects are imitated by purely basic substances such as phenylalkylamines and even simple aliphatic amines. It is difficult (for the chemist, at any rate) to believe that effector cells which are adapted to respond to minute amounts of adrenaline, and must presumably have a special affinity for it, can respond in the same way, albeit much less actively, to purely basic amines. There is, moreover, suggestive evidence that non-phenolic amines, and even some phenolic amines like tyramine, produce their effects in a different way from catechol amines. Gaddum and Kwiatkowski were the first to suggest that some at least of the effects of ephedrine were due to it inhibiting an enzymic inactivation of adrenaline, and they produced evidence that ephedrine did, in fact, preserve adrenaline in tissues.

None of this and similar evidence is discussed, although it is mentioned. The problem of mechanism is ultimately biochemical in nature, since similar physiological effects may be produced by drugs interfering at different points in a complex cycle of biochemical events. Logically, structure–action relationships should only apply to drugs all of which produce their effects by the same mechanism, but in the present state of knowledge this is probably a counsel of perfection. It may well be that some of the baffling features of structure–action relationships, which have given rise to pessimistic views like that of Clark already quoted, will disappear as more knowledge is acquired of the intimate biochemical mechanisms of drug action.

H. R. Ing

DEVELOPMENT OF LEIBNIZ'S MATHEMATICAL IDEAS

Die Entwicklungsgeschichte der Leibnizschen Mathematik während des Aufenthaltes in Paris (1672-1676)

Von Jos. E. Hofmann. Pp. vii+252. (München: Leibniz Verlag, 1949.) n.p.

ALTHOUGH this book deals only with five years of Leibniz's life, these years, spent mainly in Paris, were the decisive ones of his mathematical development. Dr. J. E. Hofmann has made a careful study of the voluminous correspondence of the mathematicians of that time and has made use of hitherto unpublished material, which is fully described.

Leibniz, born in Leipzig in 1646, received a classical, philosophical and legal education. His opportunities for gaining a knowledge of mathematics were small; but in spite of this he composed a treatise which contained the germ of many ideas developed later. He also published a treatise on motion, of which one part was communicated to the Royal Society and the other to the Paris Academy of Sciences. However, these were spare-time occupations, for by profession Leibniz was a jurist who applied legal and philosophical principles to public affairs. The reputation he gained for this work led to his dispatch on a diplomatic mission to Paris in 1672. There he met courtiers, philosophers, men of science and charlatans, wrote political reports, and projected legal reforms.

It was the influence of Huygens that was decisive in inducing Leibniz to study mathematics seriously.

Leibniz read eagerly all the mathematical works he could obtain, and endeavoured to unify the solutions of particular problems into a general method, such as that which he devised for the summation of series.

In 1673 Leibniz spent about three months in London and attended a meeting of the Royal Society, the secretary of which, Oldenburg, was a countryman of his and had corresponded with him since 1670. Leibniz was informed by Pell that the method of summation of series had already been discovered by Regnauld and published in a book by Mouton. Thus Leibniz's lack of knowledge of current mathematical literature exposed him to a suspicion of plagiarism. On his return to Paris, Leibniz made great progress. By 1675 he had developed the symbolism and most of the elementary rules of the differential and integral calculus. Newton's fluxions had been discovered about ten years previously; but this was known only to a few friends. Dr. Hofmann gives in considerable detail the development of Leibniz's form of calculus and holds strongly that it was quite independent of the work of Newton. But he also shows how several incidents, long before the unhappy controversy over the invention of the calculus, gave rise to suspicions of plagiarism.

In 1676 a letter prepared by Collins and corrected by Newton was sent by Oldenburg to Leibniz, and gave, among other results, infinite series for logarithmic and trigonometrical functions. After only a hasty reading of this letter, Leibniz sent back a prompt answer containing what he considered his own discoveries on the subject. However, these were really essentially the same as Newton's own series. Certainly they were derived in a different way; but this was not made sufficiently clear. When the letter, addressed to Oldenburg, finally reached Newton, some time had elapsed, and Newton imagined that the letter was a carefully prepared attempt at plagiarism. On another occasion, on his second visit to England, Leibniz displayed great anxiety to read and copy the manuscripts of Newton and others entrusted to Collins, and suspicion was again aroused. Dr. Hofmann deals with these incidents very fully and concludes that Leibniz's actions were really quite innocent. However, we cannot help feeling that all this was creating an atmosphere which was destined afterwards to become poisonous.

It is not certain that Dr. Hofmann's views on controversial questions will be universally accepted; but all will be interested in the study of the evidence he produces.

H. T. H. Piaggio

FARMING IN BRITAIN THROUGH THE AGES

A History of English Farming

By Dr. C. S. Orwin. (Nelson's Agricultural Series.) Pp. vii+152+24 plates. (London and Edinburgh: Thomas Nelson and Sons, Ltd., 1949.) 8s. 6d. net.

IT is widely recognized that no one can get far in the study of any subject without some knowledge of its history. This is emphatically true of agriculture, where breaks are scarce and where most things can be traced back to something that has gone before. Agriculturists fortunately possess a great classic in Lord Ernle's "English Farming, Past and Present"; but there has always been felt the need for some smaller book that would give the student a general picture in which the perspective is sound and the details, so far as they are given, accurate. Dr. C. S. Orwin's book supplies this need; in less than 150 pages he presents an account of English farm history which experts will read with pleasure and students will find most helpful.

Agriculture has been practised in Great Britain for some four thousand years; the Neolithic peoples were the first farmers, and something of their methods is now being gleaned by archæologists. By Roman times there were already tools and implements which, as Dr. Orwin says, "might be used without arousing comment by a farm worker today". Before the Norman Conquest the open-field system had developed, and of this, as might be expected, the account is full and lucid. The Black Death of 1349 intensified a change that had already begun, namely, the break-up of the old feudal system and the beginnings of independent farms, which heralded the change from subsistence farming to farming for profit with the aid of paid workers, and necessitated the enclosure of the old open fields and the consequent reduction in numbers of those having rights in land use. These changes are clearly set forth.

Then follows a section on farming in competition, showing the effects of the agricultural development of the new countries on British agriculture. The author discusses the three partners in farming: the farm worker, the farmer and the land owner. Here there is room for much controversy, but Dr. Orwin maintains a sound balance and sets out the facts clearly. He gives some remarkable instances of men who, starting in a comparatively small way, rose to very large-scale farming; such men were George Baylis, who began with 350 acres and ended up with twelve thousand acres, and Samuel Farmer, whose father had farmed 1,500 acres and who at the height of his activity was farming with his partners some twenty-five thousand acres and ended with a fortune of nearly half a million pounds. But not everyone can hope for such successes, and Dr. Orwin is somewhat pessimistic—perhaps unduly so—about farming as a career for men without capital.

Of the three partners, the land owner is nowadays probably the most handicapped in trying to discharge his duties, and some readers will think that Dr. Orwin has not given sufficient credit to the country squires for the great part they have played, and still could play but for crippling taxation, in the life of the countryside. But all who know anything about the subject will agree with his concluding sentences: "political action by the State . . . continued indefinitely can only stereotype and even sterilize the industry. History will show . . . that the advancement of agriculture is linked by unbreakable bonds with progress in the education of the farmer and research into the problems of his art." Work on these lines has been quietly going on now for some fifty years; Dr. Orwin mentions A. D. Hall, but in a future edition it is to be hoped that he will give some account of the work of the other great pioneers—T. B. Wood, Rowland Biffen, T. H. Middleton and their associates. It might be recorded, too, that Sidney Webb, one of the first Development Commissioners, was one of the stoutest supporters of the view that the Commission should foster the development of scientific research into principles rather than confine itself to finding working solutions of current problems.

The book can be cordially commended.

E. J. Russell

Klockmann's Lehrbuch der Mineralogie

Neu herausgegeben von Prof. Paul Ramdohr. Dreizehnte durchgesehene Auflage. Pp. xii+674. (Stuttgart: Ferdinand Enke, 1948.) 50 D. marks.

THIS book has become in Germany the classic exposition of mineralogical science and can be compared most directly with its American counterpart, namely, Dana's text-book published in 1932. Prof. P. Ramdohr's careful revision embodies all the advantages of a descriptive system based upon the exact measurements of the crystallographer, the chemist and the physicist. The sections on crystal form, the fine structure of crystals, the physics and chemistry of minerals and crystals, and the study of their paragenesis form an imposing prelude to the systematic description of more than twenty-five hundred mineral species.

Based upon the pioneer work of the chemist and crystallographer a century ago, these are arranged in an order that has, in its broadest aspect, undergone only comparatively minor changes during the past century. The silicates, for example, upon which so much light has been shed by the X-ray analysis of their crystal structures, can now be arranged in a manner that corresponds to their stereochemistry rather than to a series of hypothetical silicic acids. Further systematic X-ray analysis, particularly of the sulphide ores and of the lesser known sulphates and phosphates, will eventually lead to a more rational order of arrangement of the entire mineral kingdom and of related inorganic compounds.

We may expect, also, that the examination of polished ore surfaces in reflected polarized light, a method applied with outstanding success by Prof. Ramdohr in differentiating minerals and studying their order of formation and interrelations in metallic ores, will help to throw more light upon the conditions of formation of mineral veins. F. A. BANNISTER

Plants and Environment

A Textbook of Plant Autecology. By R. F. Daubenmire. Pp. xiii+424. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 36*s*. net.

THIS book is based on the author's experience of lecturing on the relation between plants and their environment to mixed groups of students, including both those whose main interest is academic and students of applied botany, and he keeps in mind the needs of the latter throughout. This has sometimes led to simplification at the expense of accuracy, as in the statement (p. 372) that "such hybridisation" (exchange of genes between ecotypes) "occasionally produces new ecotypes. Thus *Spartina Townsendii*, a natural cross between *S. stricta* and *S. alterniflora*, kills out both parents in competition. . . ."

The book includes chapters on soil, water, temperature, light, atmosphere, biotic and fire factors, followed by a short account of "The Environmental Complex" and a chapter on "Ecologic Adaptation and Evolution". The treatment is somewhat uneven. The accounts of soil, water, temperature and light are adequate, and the consideration of wind and fire as ecological factors covers ground which is often neglected. The discussion of biotic factors and the last two chapters are sketchy. A student relying solely on this book for instruction in ecology, as students of forestry and agriculture well might, would lack a realization of the importance of interaction between members of a community.

There are a number of errors in the numerical examples and a number of inaccurate statements, for example, in the discussion of pH (p. 45), "total number of H plus OH ions remains constant". The book is well illustrated; the diagrams of seasonal water changes in the soil are especially apt. The copy received for review had five paragraphs from pp. 345–6 repeated under a different heading on pp. 348–9. P. GREIG-SMITH

Outlines of Physical Chemistry

By Prof. Farrington Daniels. Pp. viii+713. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1948.) 40*s*. net.

THIS is a completely new version of the well-known book by Getman and Daniels, and provides an introductory course with emphasis on practical examples. A large number of problems are worked out in the text, and many more are given at the ends of the chapters, answers to some of these being provided. Some of the more elementary material has been omitted. More difficult parts of the subject are given in an appendix. Some literature references are given, together with lists of books at the ends of chapters; these are nearly all American.

The subjects dealt with are those taught in modern courses, and the standard is higher than that usually found in elementary books on the subject. Great care has been taken to make the text clear, and the numerous good illustrations are a help to the understanding. The curves are based on actual results. Modern developments are included, and, in addition to the usual topics, there are chapters on quantum theory, photochemistry, and atomic and nuclear structure. In the thermodynamics sections the American symbols and names are used.

There is little doubt that Prof. F. Daniels is right in his thesis that physical chemistry is best learnt in relation to numerical exercises, and his book is a very sound and attractive course. J. R. P.

Qualitative Analysis and Chemical Equilibrium

By Prof. T. R. Hogness and Prof. Warren C. Johnson. Third edition. Pp. xv+553. (New York: Henry Holt and Co.; London: George G. Harrap and Co., Ltd., 1947.) 18*s*.

THE authors express their indebtedness, among others, to J. Stieglitz, and this book might be briefly described as a modern form of his "Qualitative Chemical Analysis". Part 1 (285 pages) is wholly devoted to a theoretical study of chemical equilibrium and other physical concepts which are the foundations of analysis. The authors, in this edition, have amended their presentation in the light of experience and criticism, and have included the application of recently discovered principles. This section is well done and affords in simple language a clear account of modern theory.

The practical section (Part 2) describes the procedures and techniques for the analysis of mixtures containing the customary anions and cations. It has a novel feature—semi-micro methods only are used. The authors, from their experience, dilate on the advantages of these methods and predict their widespread adoption. The appendixes contain a section on mathematical operations, and various tables, including one of the physical properties of compounds usually present in mixtures for analysis. This is a most interesting book for all concerned with instructional analysis. G. F.

INTERNATIONAL AGRICULTURAL RESEARCH IN GERMANY

THE VOELKENRODE CENTRE

THERE is a great need to-day for facilities to enable research workers in agriculture from various countries to work together on the solution of urgent problems. In part, this need is being met in Britain at different research institutes and the universities. In Germany, at Voelkenrode, near Brunswick in Land Niedersachsen, a new centre for agricultural research has been developed since 1947 with the object of encouraging this type of research and "other scientific work related thereto and international co-operation in this respect".

One of the best ways of achieving a better understanding between nations lies in working together for improvement of the common good. Agriculture provides an excellent subject for such co-operation; and much might be gained from various countries pooling their resources of scientific man-power and equipment to tackle the grave problem of shrinking soil fertility, inadequate production and low-quality food.

It is symbolical that this new centre in Germany for constructive work has evolved from the great Hermann Goering Aeronautical Research Centre, where the prototypes of the *V*1 and *V*2 rockets were built for destructive warfare. The centre at Voelkenrode covers more than 1,250 acres and comprises more than forty buildings of various sizes. The first buildings were erected in 1936 after the area had been selected for aeronautical research because of its central position and excellent camouflage requirements. A purchase price of 4 million marks was paid by the Third Reich in 1944 for the land of the research centre. During the War, specialists and a staff of 1,500 employees were engaged on the following types of research: aerodynamics (including some remarkable developments in the supersonic field and the building of the largest wind-tunnel in the world—the Hermann Goering wind-tunnel); weapons research; chemistry of propellants; underground shooting tunnels, one of which was 400 metres long and constructed for complete evacuation of air; rocket and jet propulsion research.

After the War this great centre was occupied by the R.A.F., and valuable equipment was transferred to the Allies. It was the intention to destroy completely this huge research centre. However, a special plea was made by the Food and Agriculture Division of the Control Commission that those buildings which could be re-converted to "work for peace" as an agricultural research centre should be saved.

Following the recommendation of the Scientific and Technical Research Board and a letter dated March 4, 1948, from the Deputy Military Governor, the main area at Voelkenrode was handed over to the Food and Agriculture Division to be developed for peaceful research and education in agriculture. Developments since that date have been the result of good team-work in which the Economic Adviser, regional officers of Land Niedersachsen, Education Branch, Research Branch, Food, Agriculture and Forestry (British and American elements), the Foreign Office (German Section) and the German authorities have all participated.

The centre operates under the State supervision of Land Niedersachsen. The Ministry of Food, Agriculture and Forestry exercises State supervision in agreement with the Food, Agriculture and Forestry Administration of the Combined Economic Zone.

The organs of the Centre are the Board of Governors, the Senate and the Executive Committee. The Board of Governors consist of: (1) a representative of the Food, Agriculture and Forestry Administration; (2) a representative from each Land of the Combined Economic Zone, appointed by the highest Land authorities from agricultural circles; (3) three members of the Landwirtschaftlicher Forschungsrat set up for the Combined Economic Zone, who on its recommendation shall be appointed and recalled by the supervising authority; (4) four representatives of agricultural science from foreign countries.

The Senate is composed of the directors of the institutes of the Research Centre.

The Executive Committee of three includes the president of the Centre as chairman, his deputy and one other member of the Senate.

The Administration Director is responsible for the general business side of the Centre; but he is not a member of the Executive Committee or of the Senate.

The procedure for making appointments is that the Board of Governors draws up a short list of persons to fill a vacant appointment of director of an institute, and the final selection and appointment is made by the Senate subject to confirmation in office by the supervising authority.

A fundamental axiom of this Centre will be that its work is directed towards the maintenance of human freedom in thought and in action. Its structure will be decentralized, so that each institute possesses complete freedom to carry out its research programme. Any central establishment which may be developed will be run for the benefit of the community and not for any sectional interest.

A main function of the Centre is the provision of facilities for research students in Germany and from other countries. It is significant that research facilities in the Institute of Soil Biochemistry have already been provided for a research scholar from the School of Botany of the University of Cambridge, in addition to those for German personnel.

The following institutes have been set up and are in operation:

Soil Fertility Section. Soil Biochemistry: Director, Dr. W. Flaig. Humus Husbandry Research: Director, Dr. W. Sauerlandt. Soil Cultivation: Director, Dr. Fraser.

Plant Culture Section. Grassland and Crop Agronomy: Director, Prof. A. H. Koenekamp. Plant Culture and Seed Production: Director, Prof. W. Schulze.

Animal Management Section. Animal Nutrition: Director, Prof. K. Richter. Animal Constitution: Director, Prof. W. Zorn (situated at Grub, near Munich).

Economics and Sociology Section. Agricultural Market Research: Director, Dr. Arthur Hanau.

Agricultural Engineering Section. Fundamental Research in Agricultural Engineering: Director, Prof. W. Kloth. Tractor Research: Director, H. Meyer. Agricultural Machinery: Director: Dr. Brenner.

An Institute of General Farm Management is being planned as the twelfth institute of the Centre under the Economics and Sociology Section.

The statute which legalized the setting up of the Forschungsanstalt für Landwirtschaft as a corporation under public law was passed by the Cabinet of Land Niedersachsen in the latter part of 1949.

The Senate came into being officially on September 26, 1949, and the following positions were filled by election: President: Dr. Arthur Hanau; Vice-President: Prof. W. Schulze; Executive Committee: President, Vice-President and Prof. W. Kloth.

An area of 360 acres of the former airfield was developed for agricultural and experimental purposes during 1948, in spite of great shortages of equipment and numerous difficulties. Excellent results were obtained with all crops. Recently the Hornsen Estate, which consists of 618 acres, has been acquired for experimental purposes.

In this age, which may become known in history as the international age, marking as it does in the course of human evolution the gradual transition from rather isolated national to co-operative international endeavour, there is something significant in the setting-up of a new centre at Voelkenrode in Germany to assist co-operative research in agriculture. Agriculture has, in fact, a great role to take in providing a solid foundation for developing trust and understanding between various nations. It is our greatest industry: the fundamental basis of every country, great or small, temperate, sub-tropical or tropical. Primary and secondary industry are complementary and, in the future, as agriculture receives greater recognition and support as an essential medium for providing a balanced and flexible integration of primary and secondary industry, its importance will be greatly enhanced.

The tremendous potentialities of agriculture both as a means of supplying food to man and to animals, and as a source of raw materials for processing by secondary industry, have as yet received inadequate inquiry, support and research.

Much of the unrest, unemployment, poverty and shortages of food which have occurred since the Industrial Revolution can be traced to a grave underestimate of this basic and complementary value of agriculture. Unfortunately, it is true that much loss of valuable, or rather invaluable, top soil has occurred as a result of man's unscientific exploitation of Nature's reserves carried out under the name of agriculture; and perhaps our greatest problem of to-day and to-morrow lies in the prevention of such large-scale destruction by a world-wide development of soil conservation, and in building up soil fertility.

It is in this setting that the new centre at Voelkenrode has begun its great task. Germany has created an example of international co-operation in agriculture by arranging that the Board of Governors at this Centre shall include four representatives of agricultural science from foreign countries in addition to twelve German nominees. Voelkenrode has many well-wishers for its future success, not only in Germany but also in foreign countries.

Visitors have already been to Voelkenrode from the following countries: Australia, Denmark, Great Britain, the Netherlands, Sweden, South Africa and the United States. Dr. A. H. Boerma, European regional representative of the Food and Agriculture Organisation, visited Voelkenrode in September 1949 and met the directors of the different institutes. At a subsequent meeting of the Committee on Agricultural Technology, Dr. Boerma circulated a paper on Voelkenrode and on the activities being pursued there. The representatives of the various member governments of the Food and Agriculture Organisation present took note of the information and indicated their willingness to establish contacts with the institutes at Voelkenrode. It is of interest and indicative of the co-operative nature of the work at Voelkenrode that facilities are provided for German and foreign visitors in a well-equipped hostel possessing first-class accommodation, and it is intended that a guest house shall be opened in the near future.

It is hoped that this great venture will prove of assistance as a means of reaching a better understanding between the peoples of various nations, based on co-operative work for the benefit of all.

J. L. SCHOFIELD

CHEMICAL INDUSTRY OF GREAT BRITAIN

THE report on the present position of the chemical industry of Great Britain*, prepared by the Association of British Chemical Manufacturers in co-operation with the British Colour Makers' Association, the British Sulphate of Ammonia Federation, Ltd., the National Sulphuric Acid Association, Ltd., British Plastics Federation and the Superphosphate Manufacturers' Association, Ltd., is the result of an inquiry into the adequacy of the plans of the British chemical industry for the part it has to play in the national economy. The details of the expansion proposals supplied by individual firms are omitted from the report as confidential to the Board of Trade. Although therefore, from this report as published, it is scarcely possible to give a full answer to that question, the omission of such details does not affect the picture of general trends. The report is likely to be of permanent value for the comprehensive survey it gives of a most complex industry, or series of related industries, and of the factors upon which the development and efficiency of the industry depend.

The first chapter indicates the definition of the chemical industry adopted for the purpose of the survey, after discussion with the President of the Board of Trade. Heavy chemicals, industrial gases, fertilizers, dyestuffs, medicinals and other fine chemicals, explosives, plastics and other synthetic resins are included, but not the compounding of chemicals to make such products as paints, insecticides, sheep- and cattle-dips and pharmaceutical preparations. Synthetic fibres and rayon are excluded, but the chemical raw materials used in their manufacture are considered. A brief sketch of the historical background follows, with two chapters dealing successfully with such changes in the industry as are due to chemical research, the effects of plastics, the use of X-rays and biological advances, and a concise review of some achievements of the industry since the First World War. The industry's products are next described in seventeen groups, with a note on their inter-relationships. The supply of raw materials is reviewed in the following chapter, according to whether sufficient domestic supplies are available or whether supplies are drawn partly or wholly from overseas.

The most important natural resource of British industry is coal, which in the chemical industry is being used with satisfactory efficiency, although continuous study is given to new processes and power-generating systems that may make even better use of so valuable a raw material. Proposals for a more

* Association of British Chemical Manufacturers. Report on the Chemical Industry, 1949. Pp. 76. (London: Association of British Chemical Manufacturers, 1950.) 5s.

extended use of hydro-electric power in the electro-chemical and electro-metallurgical industries, particularly in the Highlands of Scotland, have been studied with care; but it is concluded that Scottish hydro-electric power could not be used economically for chemical manufacture unless it were supplied at preferential rates. Under present conditions, in the United Kingdom sufficient tar is being produced to supply most of the raw materials needed for chemical manufacture, and the new plant being erected for the manufacture of synthetic phenol should make further imports of phenol unnecessary. Any drastic change in the method of carbonization of coal may, however, have wide repercussions on the whole chemical industry; but, since the same basic chemicals will become increasingly available from some new oil-cracking plants, future prospects give no real cause for anxiety. The greatly increased interest in the chemistry of acetylene may lead to a substantial increase in the demand for carbide, but development in Britain of alternative processes for acetylene is regarded as a long-term project because of the heavy list of capital commitments to which the industry is already pledged.

Of raw materials coming partly from abroad, sulphur, pyrites and zincblende are of importance as sources of sulphur for sulphuric acid, supplying 47·4 per cent, 21·5 per cent and 8·5 per cent, respectively, of the output, spent oxide accounting for a further 16·5 per cent of the 543,305 tons required annually (as sulphur). In addition, about 100,000 tons of sulphur is required for other purposes. To reduce demands for imported sulphur, attempts are being made to devise a new way of making soluble phosphates without the use of sulphuric acid. Developments in the cracking of petroleum to yield relatively cheap reactive hydrocarbons are likely to have a great influence on the organic chemical industry as a whole, and particularly in the field of synthetic plastics and resins, and several large companies are embarking on special cracking processes to give high proportions of such hydrocarbons.

A chapter on research, development and technical service points out that in no industry is the importance of research and development so well appreciated. The chemical industry has little interest in the hard-and-fast line which some have attempted to draw between pure and applied research. Research, in the industry, has three objects: the discovery of new chemicals or new physical forms of old ones likely to be of use to the industry or the general public; the discovery of the most efficient means of producing chemicals and their translation to manufacture; and the discovery of the most efficient means of using these chemicals. The importance of technical service in both the export trade and the home market is stressed, and also the encouragement given by the industry to scientific publication. There is no evidence of any considerable overlap in research beyond that which is desirable; but while the industry gives generous support to fundamental research in the universities, it does not lend itself to the arrangement of a comprehensive research association. It is estimated that the industry employs on research and development 10,100 persons, including 3,000 professionally qualified scientific workers, and that the annual expenditure of £8,500,000 will rise to £11,400,000 when expansion schemes, which now number more than two hundred, are completed. Of the £8,300,000 of additional capital expenditure involved, £1,560,000 has already been spent.

In the following chapter, on process development and plant, reference is made to research on unit processes and to the need for giving every possible encouragement to British instrument makers in their efforts to produce designs comparing favourably with those from other countries. A chart giving the cost indexes for the construction of chemical plants shows that the cost of replacing plant constructed before the War is to-day almost two and a half times the original cost. This point is again stressed in the next chapter, on patents and monopoly, as one of three reasons why economic monopolies are an essential feature of efficient operation of the industry. The report emphasizes that there are often alternative materials available to users, and that monopoly in a chemical product does not necessarily mean absence of competition. A second factor is the lively sense of manufacturers of the dangers attached to a monopoly that may attract not only criticism but also the envious eyes of a competitor. It is recognized that price agreements can give rise to dangers through groups of manufacturers being less sensitive than the individual manufacturer to either criticism or competition; and the report welcomes the Monopolies and Restrictive Practices Act not only because it will protect the public against any undesirable restrictive practices by the industry, but also the industry itself against misinformed or ill-considered criticism for maintaining just those monopolies that are an essential feature of efficiency and productivity.

The location of factories, and staff and labour relations, are discussed in the next two chapters, in which the total number of employees is given as 116,569 men and 25,248 women. The scientific staff numbers 6,176 with 33,581 other administrative, technical, clerical and sales employees, of whom 12,671 are women. Works councils exist for 89 per cent of the labour in the industry, joint production committees for 78 per cent, education schemes for 90 per cent, training schemes for 79 per cent, superannuation schemes for 73 per cent, medical schemes for 86 per cent and safety schemes for 91 per cent. As evidence that the productivity of the industry is increasing, the report cites the rise in the industry's prices of only 56 per cent during the decade 1938–48, and an increase of less than half this in the price of one of its most important products, in comparison with a general rise of 124 per cent in wholesale prices. A review of future trends and expansion, from which details confidential to the Board of Trade are omitted, indicates that fruition of all the schemes, representing a total expenditure of some £200 millions and an increase of 25,000 in employees, will increase the potential annual productivity capacity of the industry by 70 per cent in terms of value. The most serious difficulty in the completion and operation of these new schemes appears to be the present scarcity of scientific and technically trained staff. Replies to a questionnaire from the Association of British Chemical Manufacturers to its members in the autumn of 1948 suggested that a 40 per cent increase in the total of 6,000 chemists then employed by the industry was likely to be required by 1953. Physicists, pharmacologists, biologists, microbiologists and mathematicians are also required, and it seems probable that for many years to come the industry could absorb more than its share of the scientific workers and technologists that the teaching institutions of Britain can supply.

Discussing in conclusion the future of the industry, the report directs attention to the marked increase

in the ratio both of new capital and of new production capacity to man-power represented by the new schemes, and estimates that in 1951 the output of the industry should be 50 per cent greater than in 1946. On completion of the expansion schemes, a reduction of imports by £28 millions is forecast by the manufacturers; but this is regarded as too high, as is the estimate of a £49 millions increase in exports (including plastics). Nevertheless, on the assumption that the plans of the industry for rehabilitation and expansion are accomplished promptly, and subject to certain reservations about sulphuric acid, it is believed that, so far as can be foreseen, the industry will prove able to meet not only the full needs of the home market, but also to eliminate avoidable chemical imports and provide a large increase in exports. It is unlikely that the expenditure on research is exceeded in any other industry in Great Britain, and the figure compares well with corresponding figures in other countries, such as the United States. The report maintains that there is evidence that the industry has within itself the resources, vigour and foresight to meet the foreseeable future and also to maintain its position in the longer term. In conclusion, it is urged that in this immensely complicated industry or series of industries, which is so often a continuous adventure into the unknown, the national interest will best be served by the utmost freedom of enterprise.

ORIGIN OF THE FLUCTUATIONS IN THE INTENSITY OF RADIO WAVES FROM GALACTIC SOURCES

Cambridge Observations

THE discovery by Hey, Parsons and Phillips[1] of a variable component of the radio emission from the constellation of Cygnus suggested that at least part of the galactic radiation was due to discrete sources of small angular diameter. Later observations by Bolton and Stanley[2] and by Ryle and Smith[3] showed that the source subtended an angle of less than 8 minutes of arc. Ryle[4] has summarized the evidence concerning the nature of the sources, and has shown that if the observed fluctuations are due to variations of the emission from the source, and are not the result of some diffraction mechanism in the earth's atmosphere, it is possible to deduce the maximum physical dimensions of the source from the observed period of the fluctuations. It is therefore of importance to determine whether the observed fluctuations are caused by some relatively local diffraction mechanism, or whether they represent genuine variations of the emission from the source.

In a private communication, Dr. J. L. Pawsey has described some experiments by Bolton, in which the source in Cygnus was observed simultaneously from sites in Australia and New Zealand. The records of fluctuations obtained in these experiments were markedly different at the two sites, and therefore suggested a comparatively local origin. In these experiments, however, the observations were made when the angle of elevation of the source was small; the radiation was therefore incident on the ionosphere and troposphere at a rather large angle. Since it was possible that the refraction effects in these experiments might cause fluctuations sufficiently large to mask any genuine variations of the incident radiation, it was decided to repeat the experiment using an observing technique which permitted observation of the source with a relatively much smaller angle of incidence (12°), for which the refraction effects should be greatly reduced. It was also possible to make similar observations of the other intense source in the constellation of Cassiopeia, which had been found in previous experiments to be relatively less disturbed.

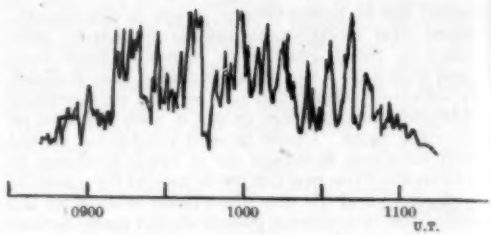

Fig. 1. Fluctuations in the radiation from the source in Cassiopeia on a wave-length of 6·7 m.; October 27, 1949

Two series of experiments have therefore been carried out; the first of these was done in conjunction with Little and Lovell, and involved simultaneous observations on a wave-length of 3·7 m., using receivers at Cambridge and Jodrell Bank, Cheshire (separation 210 km.). A detailed account of these observations is given in the following communication from Little and Lovell; but no detailed correlation between the rapid fluctuations of intensity at the two receivers was found.

The second series of observations was made by the Cambridge workers on a wave-length of 6·7 m., using spacings of up to 170 km. In these observations two types of fluctuations were found.

(1) On many nights, rapid fluctuations similar to those on a wave-length of 3·7 m. were observed; no detailed correlation was found when the receivers were separated by more than 20 km. A typical record of this type of fluctuation is shown in Fig. 1. Observations on both 3·7 m. and 6·7 m. have shown that this type of fluctuation involves variations of the intensity both above and below the mean value. This observation suggests strongly that diffraction, such as might be caused in the ionosphere, is responsible for the disturbances, although there are two difficulties in such an explanation. First, it has been found that simultaneous observations at Cambridge on 3·7 m. and 6·7 m. often show considerable cor-

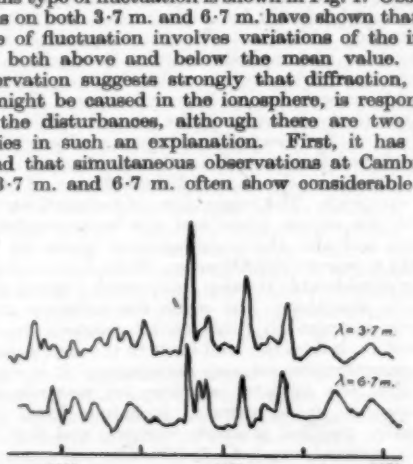

Fig. 2. Fluctuations in the radiation from the source in Cassiopeia, showing correlation between wave-lengths of 3·7 m. and 6·7 m.: July 4, 1949

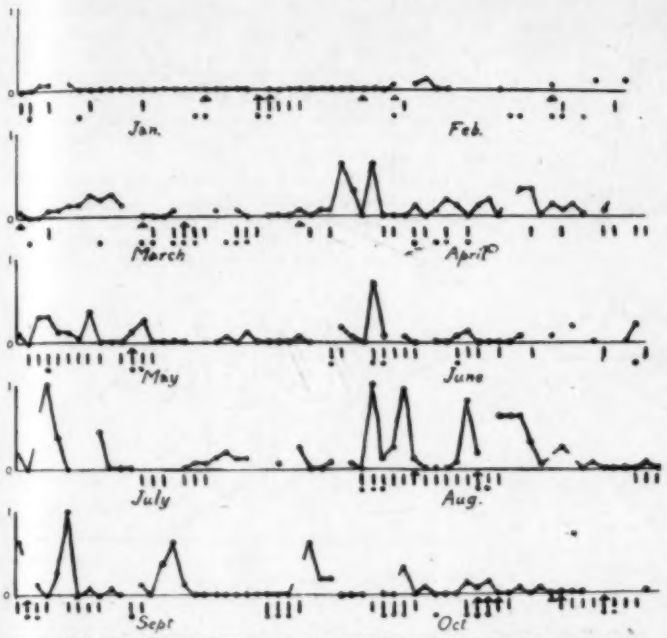

Fig. 3. Intensity of fluctuations expressed as a fraction of the mean intensity (average for the sources in Cygnus and Cassiopeia). ▲—▲—, Auroras; ▮—▮—, ionospheric storms; ●—●—, magnetic storms

relation (Fig. 2); any simple diffraction mechanism would be expected to show markedly different patterns on two such widely separated wave-lengths. Secondly, the results obtained in a series of observations on 3·7 m. over a period of ten months have shown little correlation with periods when the ionosphere was known to be disturbed. The amplitude of the fluctuations is shown in Fig. 3, together with the occurrence of ionospheric and magnetic storms and auroras.

(2) Occasionally a different type of fluctuation was observed on a wave-length of 6·7 m., which had the appearance of individual 'bursts' of large amplitude and of duration 10–20 sec. Fluctuations of this type were found to show good correlation at even widely spaced receiving sites. Fig. 4 shows simultaneous records obtained with a spacing of 160 km. This type of fluctuation was comparatively rare during the period of the observations, and it was therefore not possible to relate with certainty the direction of origin of the 'bursts' with that of either of the major sources; in view of the large spacing between the receivers, it does not appear likely, however, that the fluctuations could be of terrestrial origin, and the observations suggest that they represent genuine variations of the emission from the galactic sources.

It therefore seems likely that two separate mechanisms are responsible for the observed fluctuations. One appears to be related to variations of the emission from the sources; the brief duration of these 'bursts' suggests that the sources are of stellar dimensions. The other appears to be due to diffraction in a comparatively local region. Further experiments are necessary to confirm both these conclusions.

I should like to express my thanks to Mr. M. Ryle for his advice and help throughout this work, to Messrs. K. E. Machin and B. Elsmore for assistance in making the observations, and to Dr. N. A. de Bruyne, of Aero Research, Ltd., the Chief Superintendent of the Telecommunications Research Establishment, Malvern, and the Officer Commanding, R.A.F., Defford, for facilities in carrying out the spaced receiver observations. The work is part of a programme of research at the Cavendish Laboratory supported by the Department of Scientific and Industrial Research.

F. G. Smith

Cavendish Laboratory,
Cambridge.
Dec. 9.

[1] Hey, J. S., Parsons, S. J., and Phillips, J. W., *Nature*, **158**, 234 (1946).
[2] Bolton, J. G., and Stanley, G. J., *Nature*, **161**, 312 (1948).
[3] Ryle, M., and Smith, F. G., *Nature*, **162**, 462 (1948).
[4] Ryle, M., *Proc. Phys. Soc.*, A, **62**, 491 (1949).

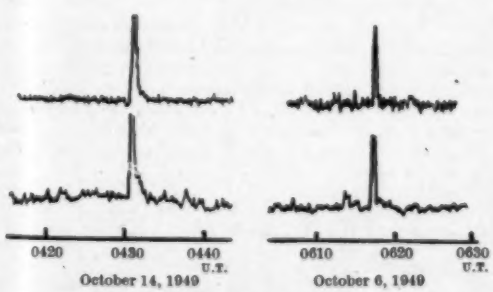

Fig. 4. Simultaneous records obtained on a wave-length of 6·7 m., with receivers separated by a distance of 160 km. Top traces, Cambridge; lower traces, Defford (Worcester)

Jodrell Bank Observations

The existence of intense sources of radio-frequency radiation in the constellations of Cygnus and Cassiopeia has been established by the measurements of Bolton and Stanley[1], and Ryle and Smith[2]. The existence of the source in Cygnus had been inferred previously by Hey, Parsons and Phillips[3] on account of the short-period fluctuations in intensity often shown by the radiation from the locality. Afterwards the source in Cassiopeia was also found to fluctuate[3], and it has been generally assumed that this variability is inherent in the source of radiation. Reasons for suspecting this assumption have been given by Smith in the accompanying communication.

In an attempt to settle this question unambiguously, a series of measurements of the radiation from the sources in Cygnus and Cassiopeia have been made in co-operation with Smith between May 1, 1949, and October 31, 1949. In this work the radiation from the

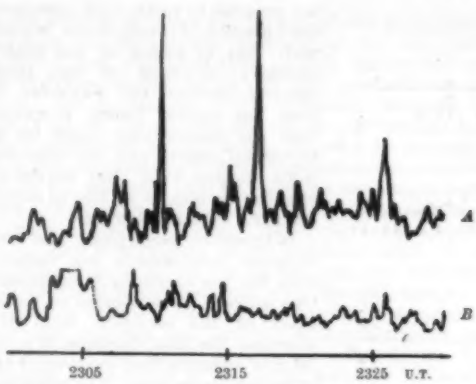

Fig. 1. Section from Cygnus transit, August 3, 1949. *A*, at Cambridge; *B*, at Jodrell Bank

sources was observed simultaneously during the transit of Cygnus and Cassiopeia at Cambridge and Jodrell Bank, Cheshire (a separation of 210 km.), using similar recording apparatus and working on a wave-length of 3·7 metres. The results of this combined work may be summarized as follows.

(1) Table 1 shows that the radiation is generally *either* steady at both sites *or* fluctuating at both sites on a given night. There are approximately 10 per cent significant exceptions when the sources fluctuate at one site but not at the other.

TABLE 1. COMPARISON OF FLUCTUATIONS ON TWO RECEIVERS SPACED 210 KM. APART

Source	No. of nights of simultaneous observations	No. steady at both sites	No. fluctuating at both sites	Fluctuating at Jodrell Bank only	Fluctuating at Cambridge only
Cygnus	94	61 (65%)	25 (27%)	5 (5%)	3 (3%)
Cassiopeia	66	43 (65%)	13 (20%)	8 (12%)	2 (3%)

(2) On the occasions when the sources show fluctuations at both sites, there is no correlation between the disturbances. This is illustrated in Fig. 1, which shows the simultaneous observations of the Cygnus source during transit at Cambridge and Jodrell Bank on August 3, 1949.

It is therefore evident that the origin of these fluctuations does not lie in the galactic sources but must be situated either in the terrestrial atmosphere or the interstellar medium. Table 2 shows that whatever mechanism is responsible, generally, but not invariably, affects both sources.

TABLE 2. COMPARISON OF THE OCCURRENCE OF FLUCTUATIONS FROM BOTH SOURCES ON THE SAME NIGHT

Site	No. of nights when *both* sources were observed at transit	No. when both sources steady	No. when both sources fluctuate	No. when Cygnus only fluctuates	No. when Cassiopeia only fluctuates
Jodrell Bank	82	48 (59%)	19 (23%)	9 (11%)	6 (7%)
Cambridge	144	81 (56%)	32 (22%)	18 (13%)	13 (9%)

A further series of simultaneous observations has been made on 3·7 metres, using two receiving sets in the neighbourhood of Jodrell Bank in an attempt to establish the amount of correlation over short distances. The results are as follows:

(*a*) With similar equipments separated on a base line of 100 metres, there is complete correlation between the fluctuations.

(*b*) Over a base-line of 3·9 km. the correlation is not complete but remains high with a correlation factor varying between 0·5 and 0·95. An example is given in Fig. 2 which shows the simultaneous observations during the transit of the Cassiopeia source.

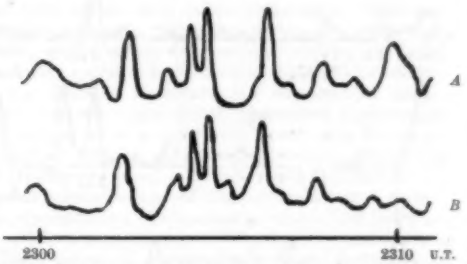

Fig. 2. Section from Cassiopeia transit, October 9, 1949. *A*, 3·9 km. south of Jodrell Bank (lat. 53° 12′ 0″ N.; long. 2° 18′ 1″ W.); *B*, at Jodrell Bank (lat. 53° 14′ 2″ N.; long. 2° 18′ 12″ W.)

This last result indicates that the origin of the fluctuations must be fairly local, and probably lies in the earth's atmosphere or ionosphere rather than in the interstellar medium. Simple considerations of the Fresnel zone theory indicate that the reversal of phase of an appreciable fraction of a zone due to localized changes in the refractive index of the ionosphere could cause fluctuations of the type observed. For example, a localized cloud of electrons 1 km. in depth in the *F*-region with a density of less than twice normal would cause a complete phase reversal. Localized disturbances in the F_2-region, with differing ionization densities and gradients, have been shown to exist by Gipps, Gipps and Venton[4]. If such a mechanism is responsible for the fluctuations, then the effect may be expected to increase in prominence with increasing angle of incidence and to show some correlation with abnormal ionospheric events.

It therefore seems likely that these fluctuations in the received intensity of the radio waves from the galactic sources are introduced in a local terrestrial medium, and are analogous to the twinkling of stars on optical wave-lengths.

We wish to thank Mr. A. Maxwell for help in taking the observations, and the Department of Scientific and Industrial Research for the financial aid given for the development of the work at Jodrell Bank. One of us (C. G. L.) is also indebted to the Department of Scientific and Industrial Research for the award of a maintenance grant during the course of this work.

C. G. LITTLE
A. C. B. LOVELL

University of Manchester.
Nov. 30.

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OBITUARIES

Dr. R. H. Rastall

ROBERT HERON RASTALL, who died on February 3 at the age of seventy-eight, was the son of H. A. H. Rastall, of Turnerdale Hall, near Whitby. In early life he was destined for a career in agricultural science, and after taking the diploma of the Royal Agricultural Society held a post on the staff of the Tamworth Agricultural College. In 1899 he went up to Christ's College, Cambridge, where he gained a first class in both parts of the Natural Sciences Tripos, specializing in geology in Part 2, and in 1903 was awarded the Harkness Scholarship for geology. During 1906–13 he was a fellow of Christ's College and in 1926 was re-elected a supernumerary fellow. In 1910 he became University demonstrator in geology and in 1919 was appointed lecturer in economic geology. He was an active member of both the Geological and Mineralogical Societies and served on the councils of both these bodies.

Dr. Rastall's scientific interests were mainly in petrology and structural geology, and between 1903 and 1914 he worked in the Lake District and in South Africa, publishing important papers on the Ennerdale granophyre, the metamorphism of the rocks around the Skiddaw granite and the Worcester District in the Cape Province; meanwhile he was engaged in the study of sedimentary petrology and the geological structure of south-eastern England. In 1911, in collaboration with Philip Lake, he published his "Text-Book of Geology" and later several other books: "Agricultural Geology", "The Geology of the Metalliferous Deposits", and "Physico-Chemical Geology". During the First World War he held a post in the War Office and, becoming impressed with the importance of economic geology, he began to apply petrological ideas to the theory of ore deposits, writing several papers and the book referred to above. In 1916 he began to assist Henry Woodward in editing the *Geological Magazine* and, in 1919, became editor, contributing many papers to its pages. In 1934 Dr. Bulman became joint editor, and this partnership lasted until his death. Meanwhile, he had been geological editor of the 1929 edition of the "Encyclopædia Britannica", to which he contributed a number of articles. About the beginning of the Second World War he retired from Cambridge to his old home at Ruswarp near Whitby and, in collaboration with Dr. J. E. Hemingway, continued to work on the Jurassic rocks. A number of papers were published, and he remained actively interested in this work until his death.

Though of a somewhat retiring disposition, Rastall was an inspiring teacher. He was known to generations of undergraduates for his help in the Sedgwick Museum; but it was in the more intimate relation of a supervisor that he will best be remembered by many. He had the gift of drawing out and developing his pupils' ideas; a quiet talk with him could always be relied upon to produce some new and interesting point of view, and he has left a lasting mark on the Cambridge school of geology.

W. H. WILCOCKSON

WE regret to announce the following deaths:

M. Denis Brocq-Rousseu, *correspondant* for the Section of Rural Economy of the Paris Academy of Sciences, at Paris on January 22, aged eighty.

Prof. S. E. Whitnall, formerly Robert Reford professor of anatomy in McGill University and later professor of anatomy in the University of Bristol, on February 19, aged seventy-three.

NEWS and VIEWS

Directorship of the British Museum (Natural History): Mr. N. B. Kinnear, C.B.

NORMAN BOYD KINNEAR, who retires from the post of director of the British Museum (Natural History) on April 30, will then have completed forty-five years of service to museums in Great Britain and India. Before he joined the staff of the British Museum in 1920, he had been twelve years curator of the Bombay Natural History Society's museum (1907–19), and for two years previous to that a voluntary assistant at the Royal Scottish Museum in his native city of Edinburgh. His work as an ornithologist is well known (see *Nature*, **160**, 252; 1947). He worked in the Bird Room of the British Museum for twenty-five years, first as an assistant keeper and, from 1927, as deputy keeper. He was appointed keeper of zoology in 1945, and in 1947, although then at the normal retiring age, he was appointed director for a period of two years in succession to the late Sir Clive Forster-Cooper. At this time repairs to the war-damaged parts of the buildings at South Kensington were well advanced and re-decoration of some of the galleries was in progress; in 1948 almost every month saw some new section of the Museum opened to the public. Kinnear secured additions to the special exhibition staff set up by Forster-Cooper and encouraged a high standard in new exhibits in every department. Improved facilities for museum lectures were provided, and a Children's Centre and Junior Naturalists' Club were started and were very successful.

The most difficult problem Mr. Kinnear had to face in 1947 was that of finding room for the great collections which had to be removed from war-damaged galleries and stored in other parts of the building. In his brief term of office, Mr. Kinnear has gone a long way towards solving this major problem. It is owing to his efforts that there is now hope of the provision in the near future of sufficient accommodation to enable the collections to be re-housed and to make them more available for scientific research than they have been since the type specimens were sent out of London in 1939. Mr. Kinnear has taken an active interest in the work of all departments and in the welfare of his staff. Outside the Museum he has served on many committees concerned with the work of museums, with the promotion of Nature reserves and of field studies. He is a vice-president of the Zoological Society and chairman of the British Section of the International Committee for Bird Preservation.

Prof. G. R. de Beer, F.R.S.

THE announcement that Prof. Gavin R. de Beer, professor of embryology at University College, University of London, has been appointed director to succeed Mr. Kinnear has given widespread satisfaction

in zoological circles and in the scientific world in general. He was educated at the École Pascal in Paris, Harrow School and Magdalen College, Oxford, where he was a Demy. He graduated in 1921 with first-class honours and was awarded the Christopher Welch Research Scholarship, was Rolleston prize-man in 1922 and a year later won a prize fellowship at Merton College which he held until he left Oxford in 1938. During this period he was also Jenkinson Memorial lecturer, and latterly reader, in embryology. In 1938 he became head of the Department of Embryology at University College, London, first as reader and then professor. He was awarded his D.Sc. in 1932 and elected a fellow of the Royal Society in 1940.

His wide range of zoological interest is shown by the subjects dealt with in his many books and papers. Apart from those which perhaps we may call his major works, "The Development of the Vertebrate Skull", "Vertebrate Zoology" and "The Comparative Anatomy, Histology and Development of the Pituitary Body", he has written books on growth, genetics, experimental embryology and an especially important study of the contributions that embryology has to make to the theory of evolution. There has been a growing feeling among zoologists that the research workers in our museums should be given more opportunity, if they wish it, for study in the field so as to bring to their taxonomic work more of the evolutionary spirit which gives life and significance to what we now usually speak of as the 'new systematics'. While the new Director can scarcely be regarded as primarily a field naturalist, his width of outlook gives us an assurance that he will be sympathetic to the need for contact with life in the field; we see him seeking refreshment in his "Escape to Switzerland" and "Alps and Men". He is also editor of *Notes and Records of the Royal Society*. In 1946 he was elected president of the Linnean Society, an office he held until 1949.

Engineering at Manchester: Prof. J. L. Matheson

Prof. J. L. Matheson, of the University of Melbourne, has been appointed Beyer professor of engineering and director of the Whitworth Laboratories in the University of Manchester, and hopes to be able to take up the appointment at the beginning of the next session. Prof. Matheson is an old student of Manchester, having graduated there in 1932. After a period of research leading to the degree of M.Sc., he spent some years obtaining practical training, after which he became a lecturer in the Civil Engineering Department of the University of Birmingham. From there he was appointed three years ago to the chair of civil engineering at Melbourne. While in Australia, Prof. Matheson has taken an active part in extra-mural activities. He is a member of the Hydro-Electric Commission for New South Wales and chairman of the Committee on Building Research. The appointment of Prof. W. R. Hawthorne to the Manchester chair (see *Nature*, March 5, 1949, p. 355) was cancelled owing to the inability of Prof. Hawthorne to accept the post.

Directorship of Aslib: Miss E. M. R. Ditmas

Miss E. M. R. Ditmas retired on February 28 from her position as principal officer of Aslib (formerly the Association of Special Libraries and Information Bureaux, with which is incorporated the British Society of International Bibliography). She had occupied this post since June 1933, first as secretary and then, since 1946, as director. Aslib loses an officer of wide experience whose work had gained the respect, as she herself had won the affection, of those who worked with her. In her early years, Miss Ditmas was best known to the general body of members at the annual conferences, to the success of which her enthusiasm, organising ability and pleasant personality contributed so much. She was always particularly interested in the technical side of Aslib's work, and was fully alive to the potentialities of such new developments as microfilming. When the outbreak of war in 1939 interrupted much of Aslib's normal activities, she played a large part in the development of services to meet the new conditions, such as the Microfilm Service and the Location Indexes for Periodicals. Much of the responsibility for representing Aslib on other bodies fell to Miss Ditmas; but her services in this capacity on such bodies as the Council of the National Book League, the British National Committee of Documentation, and, latterly, on the Library Committee of the British National Committee of Unesco, and at conferences of the International Federation of Documentation, brought her into touch with wider circles, where her enthusiasm and scholarship assisted the appreciation of Aslib's work. In post-war years the movement which led to the formation, first, of a Northern, and, more recently, of a Scottish Branch of Aslib, also owed much to her sympathy and co-operation. With the growth of Aslib, administrative responsibilities have demanded an excessive proportion of her time; her scholarly interests, so well displayed in some of her papers—notably those on special libraries given at the Royal Society's Empire Scientific Conference in 1946, on the "Co-ordination of Abstracting Services" and other papers in the *Journal of Documentation*—have suffered, and she is now devoting more time to such study and research.

Mr. Leslie Wilson

Miss Ditmas is succeeded by Mr. Leslie Wilson, a former scholar of Trinity Hall, Cambridge, and foreign editor of *The Times Educational Supplement*. After graduating from Cambridge, Mr. Wilson served for six years at home, in India and Ceylon as a Staff Officer, first in the R.A.P.C. and then in the R.A.E.C. Three and a half years with *The Times Educational Supplement* brought him many personal friendships with teachers and educational officials in all parts of the world, and he has numerous contacts with industry, the professions and learned societies in Great Britain which should stand him in good stead in his new duties. Unesco has always been the object of his enthusiastic, if often critical, interest, and his dispatches on the first Paris conference in 1946 probably did more than any other source to make Unesco's aspirations known in Britain. A fluent linguist, he is a member of Council of the Modern Language Association and editor of its journal, *Modern Languages*.

Royal Society of Edinburgh: New Fellows

The following were elected fellows of the Royal Society of Edinburgh at the ordinary meeting held on March 6: Mr. D. Band, lecturer in urological surgery, University of Edinburgh; Prof. R. M. Barrer, professor of chemistry, University of Aberdeen; Sir Alexander Biggam, director of the Edinburgh Post-Graduate Board for Medicine; Dr. C. H. Cadman, plant pathologist, University College, Dundee; Dr. N. Campbell, lecturer, Department of

Chemistry, University of Edinburgh; Prof. J. K. Charlesworth, professor of geology, Queen's University, Belfast; Prof. E. G. Cullwick, Watson-Watt professor of electrical engineering, University of St. Andrews; Prof. D. H. Everett, professor of chemistry, University College, Dundee; Mr. E. Ford, director of the Marine Biological Station, Millport; Mr. G. F. Friend, lecturer in zoology, University of Edinburgh; Dr. A. R. Gemmell, Department of Botany, University of Manchester; Mr. A. S. Gillespie, Biological Department, Loretto School, Musselburgh; Dr. J. Iball, lecturer in physics, University College, Dundee; Dr. B. C. King, lecturer in geology, University of Glasgow; Mr. J. Knox, principal geologist, H.M. Geological Survey (Scottish Branch); Dr. A. Lamont, geologist; Dr. R. C. Menzies, research chemist, Department of Chemistry, University of Edinburgh; Dr. A. Milne, principal scientific officer, Agricultural Research Unit of Insect Physiology, King's College, Newcastle upon Tyne; Prof. G. L. Montgomery, St. Mungo-Notman professor of pathology, University of Glasgow; Mr. D. E. J. Offord, superintendent, Naval Construction Research Establishment, Rosyth, Fife; Lord Patrick; Mr. G. A. Scott, head of the Natural Science Department, George Heriot's School, Edinburgh; Dr. C. A. Stewart, senior lecturer in pure mathematics, University of Sheffield; Mr. J. A. Thomson; and Prof. V. C. Wynne-Edwards, regius professor of natural history, University of Aberdeen.

University College, Makerere, East Africa

THE Secretary of State for the Colonies, Mr. James Griffiths, has announced that Makerere College in East Africa has been admitted to special relationship with the University of London, and that the Inter-University Council for Higher Education in the Colonies has agreed to recognize it as having attained the status of a university college. Students at the College will now be able to read for the degrees in arts and science of the University of London. The College, situated a few miles outside Kampala in Uganda, is an autonomous institution, supported by the Governments of Kenya, Uganda, Tanganyika and Zanzibar. The Secretary of State for the Colonies, on the advice of the Colonial University Grants Advisory Committee, has agreed to make grants totalling £1,100,000 under the Colonial Development and Welfare Act available to the College, chiefly for capital developments.

The Secretary of State also announces the appointment of Prof. Bernard de Bunsen to be principal of the College. Prof. de Bunsen was born in 1907. He was educated at Leighton Park School and Balliol College, Oxford. After wide experience in educational work in schools and administration, he joined the Ministry of Education as an inspector; he was seconded from the Ministry in 1946 to serve as director of education in Palestine. He left Palestine on the withdrawal of the British Administration and was appointed professor of education at Makerere College in May 1948. In August last year he became vice-principal of the College and also acting principal. He has travelled extensively in Europe and Africa and has a wide knowledge of foreign educational systems and methods.

Centenary Anniversary in the British Optical Industry

WILLIAM WRAY, a nineteenth-century solicitor, of Highgate, was a keen amateur astronomer and built his own telescope. Having successfully made a number of object glasses for his friends, in 1850 he converted his coach house into a workshop and set up in business as a telescope maker. Wray telescopes soon became well known and were sold all over the world; and in photography, the 'Platystigmat' was one of the first lenses with anastigmatic flattening of the field to be produced in Great Britain. In 1908 the firm was made into a limited company and came under the direction of Mr. A. A. Smith, who introduced the manufacture of prismatic binoculars. These, together with photographic lenses for aerial survey, were made in such large quantities during the First World War that the premises had to be removed to a larger site at Bromley, Kent, where they are to be found to-day. In spite of set-backs immediately after 1918, and again in 1930–31, the firm steadily increased in size in the period between the two World Wars. During 1939–45 all sorts of optical instruments were produced, one outstanding achievement being the re-designing of a 36-in. telephoto lens used for reconnaissance, which resulted in an improvement in resolution in the margin by a third. Among the things of note since 1945 may be mentioned the Wray 2-in. *F*1 anastigmat, specially designed for the photographing of transients from cathode ray tubes on to 35-mm. film, and a recent wide-angle anastigmat with focal length of 89 mm.; the latter adequately covers a half-plate, representing 100° when stopped down at *F*16, and focusing can be done at *F*6·3. As its contribution to Britain's dollar drive, Wray Ltd. exports fifteen per cent of its total output to American countries. With the present happy relationship prevailing among its workers, the firm can look back with pride on its hundred years of progress in the British optical industry.

Council for the Promotion of Field Studies

THE report for 1948–49 of the Council for the Promotion of Field Studies shows that the four field centres at Malham Tarn, Flatford Mill, Juniper Hall and Dale Fort are now open all the year round except for short breaks in the winter. The great variety of students who have already made use of the centres include a large number of groups from university departments; this demand is likely to grow as the opportunities for field work at the centres become more widely known. The University of London in particular has made great use of the centres, and students have been sent from nearly every one of the constituent colleges. For the third time practical courses for the certificate of proficiency in natural history have been held at Flatford Mill Field Centre in association with the Extra-Mural Department of the University of London. The proportion of teachers who attend courses is steadily growing; but although a number of sixth-form grammar school students have been able to make use of the centres, many have been prevented from doing so by the difficulty of obtaining grants-in-aid from their local education authorities.

Effect of Potato Virus X on Yield

POTATO virus X is economically important in the virus situation mainly because it forms a constituent of more severe disease complexes. It can, nevertheless, cause some direct reduction in yield, which has been measured by Phyllis E. M. Clinch and Robert McKay (*Sci. Proc. Roy. Dublin Soc.*, **25** (N.S.), No. 8; July 1949). They used two clones of the variety 'Up-to-Date'; one of them was reduced in yield by about

ten per cent by two strains of the virus. The other clone was not reduced in yield by either strain. These results agree with earlier studies by the same workers. It is also concluded that the reaction of the virus upon a particular clone may be considerably affected by environmental conditions.

Industrial Research and Management

A REPORT of the conference of industrial research directors and managers held at Ashorne Hill, Leamington Spa, during March 11–14 (see *Nature*, 163, 828; 1949), has now been published (pp. 123; London: Federation of British Industries, 1949; 2*s*. 6*d*.). It includes the papers presented in full, with summaries of the contributions to the discussion. A list of delegates and a list of publications of the Industrial Research Committee of the Federation of British Industries are appended.

Discussion on Heterogeneous Catalysis

THE Faraday Society is organising a general discussion on heterogeneous catalysis, to be held at the New Arts Theatre, University of Liverpool, during April 12–14, with Sir John Lennard-Jones in the chair. As a general introduction, Prof. H. S. Taylor, professor of physical chemistry in Princeton University, will deliver the Spiers Memorial Lecture (the first since the Second World War), his subject being "Surface Catalysis: Retrospect and Prospect"; this Lecture was founded in memory of Mr. F. S. Spiers, one of the founders, and secretary during 1903–26 of the Society. Forty-two papers have been prepared for the discussion, in the following four sections: (1) theories of adsorption and properties of surface layers; (2) adsorption and catalysis on metals; (3) adsorption and catalysis on oxides; (4) techniques. It is hoped to circulate advance proofs of the papers by March 29, and at the discussion authors will only be allowed to speak for five minutes on salient points. Further particulars can be obtained from the Secretary, Faraday Society, 6 Gray's Inn Square, Gray's Inn, London, W.C.1.

Conference of the Stress Analysis Group of the Institute of Physics

THE Stress Analysis Group of the Institute of Physics will be holding its fourth annual conference during April 3–5 at University College, London. The conference will begin at 3.30 p.m. on April 3 with a session on brittle lacquers. The morning session of April 4 will be devoted to papers and discussions on the use of models in structural work, including structural engineering, shipbuilding and aircraft construction. In the afternoon the topic will be on recent developments in photo-elasticity. The morning and afternoon sessions of April 5 will be devoted to papers and discussions on the application of experimental stress-analysis methods to soil mechanics problems, and on experimental stress-analysis methods in the motor industry, respectively. The conference will be open to the public. Further particulars can be obtained from the honorary secretary of the Stress Analysis Group, Mr. E. K. Frankl, Engineering Laboratory, Cambridge.

Fellowships for Cancer Research

THE British Empire Cancer Campaign is inviting applications for fellowships in cancer research. Senior fellowships will normally be tenable for seven years at a salary of £2,000 rising by £100 increments to £2,600 per annum; junior fellowships will be tenable for three years at a salary of £1,000 rising by £100 increments to £1,200 per annum. Fellowships are open to graduates of British nationality with no restrictions as to age, although the election of a junior fellow above the age of thirty-five is unlikely. The first elections will take place in June this year, and work, if possible, will begin on October 1. Fellows must carry on their research initially in Great Britain or in Northern Ireland, and only at the place at which they are authorized by the Campaign to work. The fares of successful candidates from overseas will be paid by the Campaign. Further particulars and application forms, to be returned by May 1, can be obtained from the General Secretary, 11 Grosvenor Crescent, Hyde Park Corner, London, S.W.1.

Cecil Peace Prize

THE 1949 award of the Cecil Peace Prize has been divided between Mr. M. Foss, of Jesus College, Cambridge, and Mr. P. J. Gilder, of King's College, Cambridge. The subject of the essay was "What international action should be taken with regard to the many millions of displaced or expelled persons and refugees in Western Europe, with a view to both the restoration of European economy and to the utilisation of labour power now running to waste". The Prize is an annual award, worth £100, and is open to all members (less than twenty-five years old) of the universities of the United Kingdom. The subject for 1950 is: "What is meant by the Balance of Power? And has its attempted maintenance since 1660 been useful for Peace or not?" Essays must be sent in before November 1 to the Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1.

Announcements

GUSTAVO COLONNETTI has been elected *correspondant* for the Mechanics Section of the Paris Academy of Sciences in place of M. Maurice Roy, who has been elected a member of the Section. Hans A. Pallmann has been elected *correspondant* for the Section of Rural Economy in place of the late M. André Boivin.

MR. F. P. SLATER, of Fine Spinners and Doublers, Ltd., Rock Bank, Bollington, near Macclesfield, has been elected an honorary life member of the Textile Institute, in recognition of his services to the Institute.

THE Chemical Society invites applications for grants for research in all branches of chemistry. Such applications must be submitted on the appropriate form, not later than May 1, to the General Secretary, Chemical Society, Burlington House, Piccadilly, London, W.1, from whom further particulars can be obtained.

AN international symposium on ultrasonics, organised by the Italian National Research Council and the Italian Physical Society with the collaboration of the International Union of Physics, will be held in Rome during June 14–17. Arrangements for the symposium are being made by Prof. Amadeo Giacomini, professor of physics, University of Trieste.

A LIST of papers, corrected to January 21, has recently been published in connexion with the Fourth World Power Conference, to be held in London during July 10–15 (see *Nature*, December 17, 1949, p. 1035). Applications for membership can still be accepted, the forms being obtainable from the Offices of the Fourth World Power Conference, 414 Cecil Chambers, 76 Strand, London, W.C.2.

MICRORADIOGRAPHIC DEMONSTRATION OF TISSUES TREATED BY METALLIC IMPREGNATION

By Prof. G. A. G. MITCHELL
Department of Anatomy, University of Manchester

VARIOUS earlier attempts to obtain minute radiographic detail culminated in the remarkable results reported by Lamarque (1938)[1]. He used very soft X-rays (2–12 A.) and films coated with extremely fine emulsions of the Lippmann type invented for interferential photography. His equipment was elaborate, consisting of a special generator, a camera sealed to a diffraction X-ray tube so that both could be evacuated to a high vacuum, a lithium window and an ingenious plate changer.

By means of his apparatus Lamarque obtained what he termed microradiographs, and owing to the extremely fine grain of his films he could examine them microscopically and obtain magnifications up to 250 or more by microphotography.

Doubtless owing to the complicated nature of his equipment, apparently the only serious attempts to follow Lamarque's lead were made by Bohatyrtschuk (1944)[2] and Barclay (1947)[3]. The latter evolved a simpler technique involving the use of a modified two-valve generator, a standard diffraction tube, and maximum resolution plates; and while he failed to obtain detail comparable to Lamarque's best, nevertheless his methods provided excellent results. He obtained a × 50 enlargement from his microradiographs by microphotography, and then printed off enlargements from the microphotographic negatives. He used his method mainly to study the arrangement of vessels injected with radio-opaque solutions, but in one case (Barclay, 1949)[4] he demonstrated iron in a lung almost as clearly as Lamarque *et al.* (1936)[5] had shown bismuth salts in the spleen.

One had the idea that Barclay's methods might be employed to study the arrangement of various tissues having a selective affinity for silver salts. In particular, it was hoped to obtain a clearer picture of intrinsic glandular innervation, a subject still shrouded in considerable obscurity; but the existing metallic techniques are notoriously capricious when applied to such viscera, and no good pictures have yet been obtained of the ramifications of nerves within glands. It is possible, however, to demonstrate larger nerves (Fig. 1) and nerve bundles (Fig. 2) in sections stained by Cajal's, Bodian's, Romanes's and Wrete's techniques, and probably much finer filaments could be demonstrated by using the Lamarque type of equipment.

Reticular tissue also has argyrophil properties and can be revealed by microradiography after appropriate staining, for example, by Gomori's or Lillie's techniques. In the microradiograph reproduced (Fig. 3), the reticulum may appear unduly conspicuous to those accustomed to looking at ordinary histological slides; but the picture was obtained from an 80-μ section.

It is usually believed that nerve and reticular fibres have a greater affinity for silver than most other tissues; but microradiography raises doubts about this. Certainly muscle and collagenous fibres show up well in microradiographs of sections stained by silver techniques (Fig. 4). Indeed, the collagenous bundles constituting tendons cast denser shadows than nerves of approximately equal size. It is therefore possible that the relative histological prominence of nervous and reticular tissue in silver-impregnated sections is due, not to their selective affinity for the metal, but to some physico-chemical interaction with it which does not occur to the same extent with other fibres, and which renders them darker in colour when viewed through the microscope. Some claim that reticular fibres are immature collagen and that in silver-stained microscopic sections direct continuity between the darker reticular and paler collagenous fibres may sometimes be traced. In

Fig. 1

Fig. 2

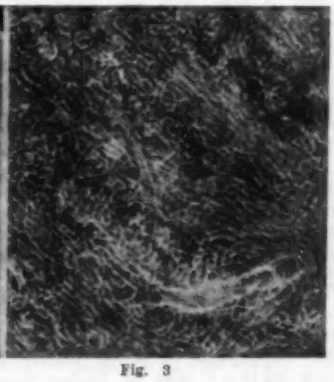

Fig. 3

Fig. 1. Microradiograph (× 73) of region of metacarpal head in human fœtus impregnated by Wrete's method. 1, Nerves. 2, Vessels. 3, Collagenous fibres. The metacarpal head is outside the field reproduced

Fig. 2. Microradiograph (× 80) of delicate retroperitoneal plexus adjacent to intermesenteric nerves (pre-aortic plexus) stained by Bodian's method. Most of the filaments visible are delicate nerves, but some are collagenous fibres

Fig. 3. Microradiograph (× 34) of reticular network in monkey's kidney stained by Gomori's method

Fig. 4. Microradiograph (× 12) of human fœtal arm impregnated by Wrete's technique. Certain bony and muscular details are apparent and the tendons (which are largely collagenous) are clearly visible, for example, the tendons of biceps brachii

microradiographs colour variations are absent and they reveal that, despite the histological evidence which apparently shows that collagenous are much less argyrophil than reticular fibres, in fact both attract silver almost equally. This is exemplified in structures such as the spleen, the lymph nodes and the kidney, where the capsules, which are mainly collagenous, show up as clearly in microradiographs as the reticular tissue within them.

Thick sections (40–400 μ) have to be employed in microradiography by Barclay's technique for two main reasons: (1) thin sections do not contain enough metal to cast good shadows unless one is fortunate enough to possess the Lamarque type of equipment; and (2) the exposures vary between two and fifty minutes, and during this time it is difficult to avoid drying and crinkling of thin sections, with consequent blurring of the picture. The air cannot be humidified because this would hinder the passage of soft X-rays, and any moisture on the photographic plates increases the length of exposure required.

Thicker sections have some positive advantages. They enable the investigator to trace the arrangement of fibres over greater distances than is possible in ordinary histological sections (average thickness 5–10 μ), and if combined with stereoscopic methods of microradiography they may provide a possible alternative to the drudgery of serial sections and wax reconstructions for certain purposes, for example, studies of the distribution of nerves or of ossification. Bony structures have the advantage that they are naturally radio-opaque.

The lack of sharp definition in microradiographs is due to a combination of causes: X-ray scatter; the thickness of the sections used; the fact that some deposition of silver occurs throughout the entire section; and at higher magnifications the granules, even in fine photographic emulsions, become apparent.

In conclusion, it must be emphasized that microradiographs are merely shadows, revealing in a relatively easy way the pattern in which certain tissues are arranged. They are an adjunct to, and not a substitute for, ordinary histological methods.

I am indebted to Prof. M. Wrete of Uppsala, who kindly gave me a fœtal limb impregnated by his method[6]. My thanks are also due to Messrs. F. L. Newell, H. Gooding, K. Pearson and P. Howarth for radiographic, photographic and histological help. The cost of the investigation was partly defrayed with the aid of a technical expenses grant from the Medical Research Council.

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MUSCLE PROTEINS AND THEIR INTERACTION WITH ADENOSINE TRIPHOSPHATE

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In recent years, such conflicting statements of the action of adenosine triphosphate on actomyosin have appeared[1,2,3], that it has appeared impossible to decide on the actual mechanism involved. During the course of an investigation of the muscle proteins by ultracentrifuge and light-scattering methods, some clear-cut results have emerged and these are outlined below. A more detailed report will be presented elsewhere later.

It is necessary first to review briefly the nature of the various muscle fractions, prepared from rabbit muscle by the methods of Szent-Györgyi and his school, as shown by ultracentrifuge examinations. Least complicated, it would appear, is the so-called crystalline myosin, which, on the basis of several preparations, sediments as a single (perhaps composite) peak over a range of protein concentrations up to 0·8 gm./100 c.c., and between 0·3 *M* and 0·6 *M* potassium chloride. Sedimentation is apparently unaltered by the presence of 0·1 *M* magnesium chloride with 0·3 *M* potassium chloride. Fig. 1*a*, showing the sedimentation of myosin in 0·55 *M* potassium chloride at a protein concentration of 0·2 gm./100 c.c., is very reminiscent of the sedimentation of linear polymers[4,5], and it should be noted that in such cases the absence of peak-spreading during sedimentation cannot be assumed a proof of monodispersity, since concentration effects cause an artificial sharpening of the boundary. Even so, however, a considerable asymmetry of the boundary is sometimes observed, and at low protein concentrations (less than 0·2 gm./100 c.c.) normal boundary-spreading occurs (Fig. 1*b*). The sedimentation constant in 0·5 *M* potassium chloride, extrapolated to infinite dilution and corrected to the viscosity and density of water (s^0_{20}), is 7·2 S., in agreement with the published value of Snellmann and Erdos[4]. Below 0·3 *M* potassium chloride, aggregation of myosin appears to occur, resulting in a polydisperse and a 'multi-peak' sedimentation diagram.

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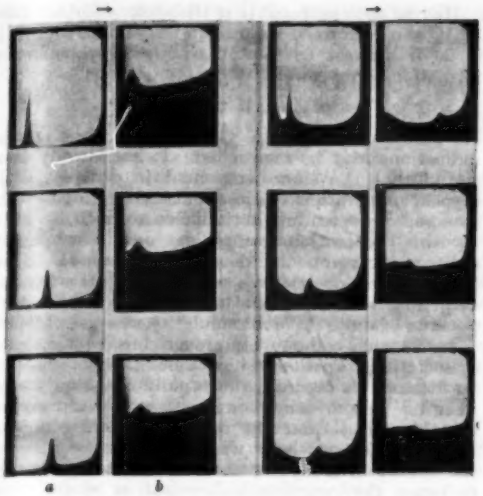

Fig. 1

Fig. 1. Sedimentation diagrams of myosin in potassium chloride solution
(*a*) Protein concentration = 0·2 gm./100 c.c.; KCl = 0·55 *M*; *p*H = 8·0
(*b*) Protein concentration = 0·045 gm./100 c.c.; KCl = 0·50 *M*; *p*H = 7·4

Fig. 2

Fig. 2. Sedimentation diagrams of water-extracted actin in 0·05 *M* KCl, *p*H = 7·1

The addition of 0·0016 *M* adenosine triphosphate to myosin solutions caused no change in the sedimentation diagrams, in the observed sedimentation constant, or in the solution viscosity.

In contrast to myosin, actin appears from the ultracentrifuge to be a very ill-defined and somewhat variable material (Fig. 2). In order to remove charge effects in the sedimentation of charged colloids, it is necessary to work in the presence of appreciable salt concentrations. Accordingly, it is not possible to study *G*-actin under the conditions postulated by Szent-Györgyi. In 0·05 *M* potassium chloride, over a protein concentration-range of 0·2–0·3 gm./100 c.c., the sedimentation diagrams of actin usually show two main components: a fast, sharp peak with a sedimentation constant c. 50 S. and a slow, asymmetric and rapidly spreading peak with a range of sedimentation constants from 4·5 to 6·0 S. The addition of 0·002 *M* adenosine triphosphate to an actin solution in 0·5 *M* potassium chloride gave no significant change in relative viscosity.

Actomyosin, while somewhat variable from preparation to preparation, is much better defined than actin. In Weber solution (0·6 *M* potassium chloride; 0·04 *M* sodium bicarbonate; 0·01 *M* sodium carbonate) actomyosin sediments as two main components (Fig. 3), one of which, the slower one, somewhat variable in quantity, is usually indistinguishable in sedimentation from myosin. This was shown by addition of a myosin solution to that of actomyosin, when the only observable result was an increase in the slow actomyosin peak. In other cases, however, the slow actomyosin peak was less well defined, showing greater spreading than expected of myosin and more reminiscent in this and its sedimentation-rate of actin. The rapid peak of actomyosin showed large concentration effects, possessing an s^0_{20} value in excess of 60, while at a concentration of 0·13 gm./100 c.c. the sedimentation constant was 15 S. As a result of such concentration effects, except at very low concentration (less than 0·10 gm./100 c.c.) this rapid peak was extremely sharp and easily visible. Changes in it, with which we are concerned below, were therefore readily observed (Fig. 3).

Myosin and actin solutions in 0·5 *M* potassium chloride, when mixed over a range of relative and absolute concentrations, showed large increases in viscosity and indications of gel structure. Thus, on adding 8 volumes of a 0·2 gm./100 c.c. myosin solution of relative viscosity 1·46 to two volumes of an *F*-actin solution of relative viscosity 2·175, the observed relative viscosity was 1·89, while on adding 0·2 volumes of 0·1 *M* adenosine triphosphate solution to the mixture, it became 1·495. Assuming simple additivity of the viscosities of the two components, the calculated relative viscosity of the mixture is 1·60, which is significantly higher than the observed value for the mixture after addition of adenosine triphosphate. On Szent-Györgyi's views, this is explained by the regeneration of the actin from the actomyosin complex in the *G*- rather than the *F*-form in which it largely occurred initially.

Such mixtures were also examined in the ultracentrifuge, and in addition to a complex gel-like component which sedimented rapidly and completely at 60,000 *g*, it was confirmed that the usual actomyosin sedimentation diagram with a rapid, sharp peak and a slower component was observed. It is probable that the gel-like component arises as a result of the higher actomyosin concentration in

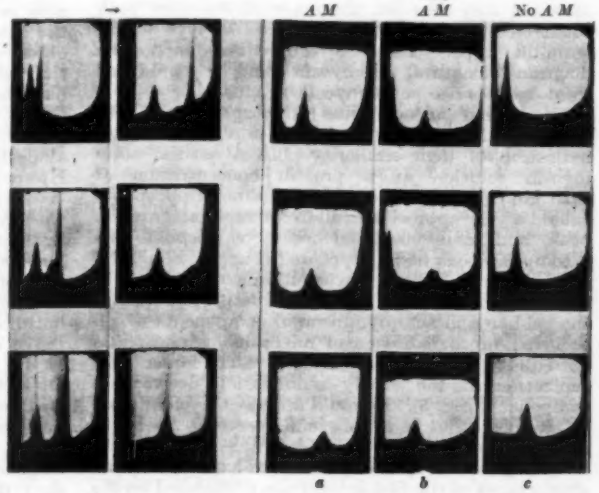

Fig. 3

Fig. 4

Fig. 3. Typical sedimentation diagrams of natural actomyosin in Weber solution. Protein concentration = 0·35 gm./100 c.c.; *p*H = 8·4

Fig. 4. Action of adenosine triphosphate on natural actomyosin. Sedimentation diagrams in Weber solution of:
(*a*) Natural actomyosin. Protein conc. = 0·25 gm./100 c.c.
(*b*) ,, ,, + 0·002 *M* adenosine triphosphate
(*c*) ,, ,, + 0·009 *M* ,, ,,

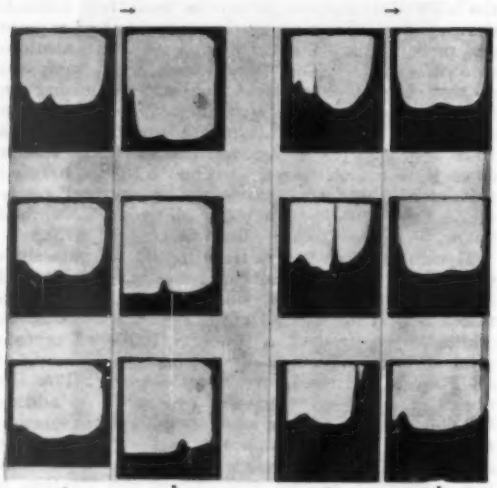

Fig. 5

Fig. 6

Fig. 5. Action of adenosine triphosphate on synthetic actomyosin in solution containing 0·5 *M* KCl and 0·0003 *M* $MgCl_2$.
(*a*) Synthetic actomyosin. Protein conc. = 0·25 gm./100 c.c.
(*b*) " " + 0·012 *M* adenosine triphosphate

Fig. 6. 'Dissociation' of actomyosin. Sedimentation diagrams in Weber solution of:

(*a*) Natural actomyosin. Protein conc. = 0·30 gm./100 c.c.
(*b*) Solution of rapidly sedimenting component of (*a*). Protein conc. *c.* 0·2 gm./100 c.c.

mixed myosin–actin solutions than can be obtained by actomyosin extraction by buffer solutions.

By changing the relative concentrations of the two components from high myosin to high actin, it was observed also that the character of the slow peak could be changed from the myosin-like type to the actin-like type. Thus the different sedimentation diagrams of natural actomyosin could be reproduced from appropriate actin–myosin mixtures.

The action of adenosine triphosphate on both natural and synthetic actomyosin provides a further indication of their similarity. In a natural actomyosin solution at a protein concentration of 0·25 gm./100 c.c., 0·002 *M* adenosine triphosphate caused a very appreciable fall in the rapid actomyosin peak, and at 0·009 *M* adenosine triphosphate the actomyosin peak had disappeared (Fig. 4). Similarly, in a synthetic actomyosin solution containing 0·17 and 0·08 gm./100 c.c. of myosin and actin respectively, the gel-like and actomyosin rapid components which occurred in the absence of adenosine triphosphate both disappeared in favour of a much larger concentration of the slowly sedimenting actomyosin component (Fig. 5). It would appear, therefore, that in sedimentation behaviour and reactivity to adenosine triphosphate, natural and synthetic actomyosin do not differ. Nor is it possible to explain the disappearances of the fast actomyosin component on the basis of a coiling of the actomyosin chains. Such coiling would only give a component of altered sedimentation constant, but would not cause its disappearance. The increased concentration of the slow actomyosin components can only mean dissociation of the complex into either its constituents or into components of similar sedimentation properties.

Having demonstrated that the actomyosin complex (AM) can be formed from actin (A) and myosin (M), it is of interest to inquire whether such complex formation is reversible, that is,

$$A + M \rightleftarrows AM.$$

No definite answer can yet be given, but certain indications may be mentioned. It has already been stated that the slow component in different actomyosin preparations varies from a sharp myosin-like to a rapidly spreading actin-like material. No actomyosin preparation containing only the rapidly sedimenting component has yet been made. Since each preparation involves several precipitations, it is surprising that a better separation from other components of quite different solubility was not obtained —unless such components are produced by complex dissociation. Further evidence has been provided in an attempt to separate the rapidly and slowly sedimenting actomyosin components by ultracentrifugation in a quantity rotor. Centrifugation at 140,000 *g* for one hour was sufficient, according to the results of analytical sedimentation experiments, to cause the complete sedimentation of the rapid actomyosin component, and after this treatment the supernatant liquid could be poured cleanly away from the firm gel-like sediment. The sediment was stirred and extracted with the original volume of Weber solution for 19 hr. With the original actomyosin solution, this solution was examined in the ultracentrifuge. Typical sedimentation diagrams for both solutions, shown in Fig. 6, show the surprisingly high relative concentration of the slow actomyosin component in the dissolved sediment. Assuming equal refractive index increments for the two components, the ratio $\frac{[\text{fast}]}{[\text{slow}]}$ has the values 1·1 and 1·0 for the original solution and extracted sediment respectively. It is further to be observed that the slow component in Fig. 6*b* has now much more of the character of myosin, which in the concentration observed could only appear from the dissociation of the sedimented actomyosin complex. These results have been repeated and confirmed.

The complex composition of some of the muscle protein solutions indicates the dangers of interpreting alone the results of colligative or similar methods. However, possessing results from sedimentation velocity analysis, such results may be interpreted with more confidence. In particular, a comprehensive light-scattering investigation of the muscle proteins has been carried out, and, although complete results are not yet available, it would appear that they are in general agreement with the ultracentrifuge work outlined above.

We acknowledge with pleasure our debt to Prof. E. K. Rideal for his interest in the work. To Dr. D. F. Cheesman and the Physiology Department of Bedford College, University of London, we are grateful for laboratory facilities, and one of us (R. L.) is indebted to Schweizerische Stiftung für Stipendien auf dem Gebiete der Chemie for a scholarship during the tenure of which this work was performed.

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RECENT BREEDING PHENOMENA IN THE AMERICAN SLIPPER-LIMPET, *CREPIDULA FORNICATA*

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IN the absence of intensive cultivation during the War, the American slipper-limpet, *Crepidula fornicata*, further established itself[1] as the dominant organism on the Essex oyster beds and thus attained the optimum state[2] for producing annual crops of young, namely, spatfalls. Nevertheless, in 1945 the spatfall was a virtual failure—resembling similar failures from time to time in the spatfall of the oyster—thereby providing a fact of considerable biological interest, since no failure has previously been recorded, although almost continuous observation has been kept on the species since 1910.

The virtual absence of the spatfall was observed during August 20–21, 1945, when the grounds of the Blackwater and Roach were thoroughly surveyed—by courtesy of Major A. Gardner—from a motor-boat towing four dredges.

On this date the slipper-limpets were found to be still breeding, covering capsules some of which contained recently spawned ova, some with veligers and some empty; thus larvæ were being produced at this time. There is evidence that planktonic conditions had been suitable for larvæ, as at the time of the survey there had been a moderately good fall of oyster spat in the Blackwater (5, 6 and 7 spat per shell being common, with a maximum on one shell of 32) though only a relatively poor fall in the Roach. In a season of good spatfall in the past, the young slipper-limpets would be at least as numerous as the oyster spat recorded in 1945 on the Blackwater and certainly far more numerous on the Roach; but in that year only occasional limpet spat were found. As a rough indication of frequency, thirty-four clumps (averaging seven to eight individuals) of slipper-limpets were taken at random and examined on the boat on August 21, 1945, for limpet spat; thirty-three of these clumps had no spat and only one had a 1945 spat, while only two chains had members 15–20 mm. long (1944 spat). In a comparable sample examined at Liverpool, taken on December 16, 1947, among eighty-one clumps (averaging about five individuals) fifty-eight had collectively 106 spat, twenty-three had none and eight spat were loose. Thus in this rough comparison, which has necessarily a limited value, limpet spat were at least fifty times more abundant in 1947 than in 1945. Estimations of spatfall in the future made on a more solid basis are desirable for following up this aspect of the biology of the slipper-limpet. The paucity of the spatfall in 1945 was checked and confirmed by the examination of four samples of about fifty clumps each, taken at the end of the season, in October 1945 and February 1946.

The rarity of young slipper-limpets in August 1945 had been noticed by the oyster dredgermen, who, along with Mr. E. Luckhurst, stated that spatfall had been poor or absent on some grounds also during some of the war years, but that oyster spatfalls had been good at times where there was no limpet spatfall. Mr. Luckhurst also states that there was a sprinkling of slipper-limpet spat in the Roach in 1946, but it did not live. It is therefore quite clear that after a successful and rampant invasion of the Essex oyster beds[3], *Crepidula* has recently suffered a check and is exhibiting some maladjustment with its new environment, and there is every reason to infer that the check is due to natural causes.

No satisfactory explanation can, however, be given for the failure of young limpets to settle in 1945, or during the war years. It was at first thought that the severe winters during the War—including 1945 when ice occurred on the oyster beds—may have affected the viability of the adults, particularly as after the extreme cold of February 1940 an *ad hoc* survey[4] showed that on the same grounds oysters were annihilated or succumbed in high proportions on some beds, and that slipper-limpets generally were weakened excessively and suffered some mortality. But the revival in spatfall of limpets in 1947, after the intensely cold period in February of that year when ice was generally prevalent in the Thames estuary, renders this explanation doubtful. Nothing is known of the parasites of *Crepidula* in British waters, so that this attractive problem remains to be investigated and may be related to the phenomena observed.

As slipper-limpets pair in the winter period, it seemed also probable that the reproductive products might be affected by long periods of low temperature especially if accompanied at times by low salinity. Little is known of the breeding habits of *Crepidula fornicata* in Great Britain apart from the hitherto unrecorded occurrence of a high proportion of copulating pairs in a sample of chains kept in dishes in the Plymouth Laboratory during the consecutive months of November, December 1911, and January and February 1912. The same pairs were seen in copula intermittently over a period of several days. Pairing can occur between couples in any position in a chain, for example, the second and third in a chain of five, or the fifth and ninth in a chain of eleven. It is significant that a small male individual was observed attempting to pair with a female four to five times its own size; thus it is possible that one-year old spat may function as males. Some of these pairings occurred after the dishes had been moved from a cold slab to the warmer bench, with a consequent rise in temperature of the water; their observation was, however, incidental to the work carried out at the time. It is an interesting fact that in a repetition of the observations in December 1912–January 1913, some individuals kept in the tanks had spawned on January 31, whereas none was found with spawn among a few large consignments received later direct from the Essex beds until March 7, when three individuals were covering spawn out of a sample of four to five hundred individuals (about two hundred females).

From field observations it is probable that pairing occurs generally in late autumn and early winter as well as at other times, the female storing the sperm in recepticula seminis until spawning begins during February–March. Intense cold with low salinity may affect spawning behaviour, though it is doubtful whether mere low temperatures would affect the viability of sperm. It is not improbable, on the other hand, that the effect of unfavourable conditions on the female might be reflected in the viability of the larva. In this respect there is reason to suspect that failure to obtain spatfalls of oyster larvæ in ponds, where the parent oysters used have been transported from some distance, may be due to the weakening effects of transport reflected in the reproductive products, and failure of the larvæ to settle. Definite

evidence of the effect of extreme cold in preventing spawning of plaice in ponds in 1947 is given by Smith[5].

While normal crops of young marine animals are dependent upon a normal seasonal integration of life in the sea, each successive phase in the life-history being dependent upon normal environmental conditions, including the provision of appropriate food-organisms—and only normal prevalence of predators and parasites—the failure of crops may be due either to deviations from these conditions, or perhaps more usually merely to hydrographic accidents which prevent the larvæ from arriving over suitable ground for settlement at the right time[6]. Nevertheless, there is no reason to relate the failure of the spatfall of *Crepidula* in 1945 to hydrographic accidents, as their larvæ would co-exist mainly with those of the oyster which settled. Known absences of young of such forms as *Aplysia*, *Grantia*, *Archidoris* (at Plymouth) and even oysters (Essex estuaries) may be referred at times to the accident category. On the other hand, although years of unusual abundance (for example, oysters[7], *Mytilus*[8]) of species are generally bound up with problems of population, distribution, and appropriate general environmental and food conditions, as noted above, the less obvious factor of good physiological conditions of the adults, though important, can rarely be assessed and is generally presumed.

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INTERNATIONAL SECRETARIATS

FIVE years ago, the problems arising in the staffing and administration of an international secretariat were discussed in the light of experience gained with the League of Nations in two pamphlets issued by the Royal Institute of International Affairs (see *Nature*, **154**, 221, 1944; **157**, 308, 1946). Those problems as they affect the United Nations and some of the Specialized Agencies have been examined recently after the further experience of their first formative years by Political and Economic Planning, and two recent broadsheets (*Planning*, Nos. 298 and 307) attempt to indicate broadly some of the problems most urgently in need of solution and to describe in broad terms the way in which they have been tackled by the United Nations and its agencies. The first of these broadsheets surveys the staffing problems, while the second reviews the broad question of the functions of the secretariats and their relation to their respective policy-making bodies.

The creation of a balance between national and international loyalties was a problem which the League of Nations had to face early in its history, and the broadsheet quotes from Sir Arthur Salter, writing in 1930, on the necessity of some senior officers in an international secretariat possessing international loyalties which transcend the acceptance of instructions from their own national governments. Experience of the League of Nations and of the International Labour Organisation seems, in fact, to demonstrate that the concept of international loyalty is practicable. An administration drawn from nationals of many countries can be highly efficient, and a secretariat the members of which consistently display international loyalty will readily command the confidence of national delegations. Delegations will readily supply it with information, and its advice is more readily accepted when its impartiality is trusted.

Discussing the geographical distribution of the staff and the difficulty of ensuring a wide distribution and the highest standards of competence, integrity and efficiency, P E P believes that, on balance, in an international organisation mere efficiency cannot be, and perhaps should not be, the only aim. Provided there is enough flexibility to avoid unsuitable appointments to key positions, some concession to national feeling among member States may in the long run result in more gain than loss.

Discussing next the question of appointments, P E P suggests it may be too early to say what balance should be struck, as a long-term policy, between permanent and temporary staff. The recommendations of the Preparatory Commission of the United Nations gave insufficient weight to certain factors affecting especially the less-developed countries. Moreover, while it may be an advantage from some points of view to have easy and frequent interchange of national and international officials, the larger proportion of short-term staff does involve the danger that national Civil servants seconded for a short period only may retain their national feelings throughout their appointment and fail to assume an international loyalty. Nevertheless, *Planning* suggests that the problem is largely one of emphasis and timing, with the ideal proportions of permanent and short-term appointments varying from time to time according to the nature of the work to be done and the availability of suitable people.

As regards qualifications, P E P points out that until certain matters of basic policy, such as the nature of research work to be undertaken by a particular section and the nature and administrative responsibilities of the high posts in relation to the whole organisation, are settled, one of the most urgent tasks is a broad classification of posts into those normally filled by specialists, those normally filled by general administrators, and those in which there will always be some interchange. Moreover, the specialist character of the secretariat will largely determine the extent to which outside consultants are used, and here *Planning* suggests that fuller use might with advantage be made of "corresponding consultants". Commenting on the different recruiting methods adopted empirically by the United Nations and the Specialized Agencies, it suggests that, from the point of view of the applicant, a common recruiting agency for all the organisations would be of great advantage, but that it is doubtful whether such an agency is really feasible. Much could be done to eliminate competition in such grades as linguistic and clerical staff, and there is room for co-operation in arranging preliminary competitive examinations for candidates offering themselves specifically for different organisations, as well as in the standardization of forms of application and in interviewing by common recruiting officers.

Security of tenure is governed by staff regulations, ranging from temporary contracts which carry a month's notice at any time, without cause assigned, with an indemnity payment varying with the length of service, to appointments of indeterminate length, subject to review every five years only on grounds

of efficiency, and terminable, apart from misconduct, only on grounds of inefficiency, abolition of the post, or lack of budgetary provision. The feeling of insecurity from which many members of the staff apparently suffer is not due only to the absence of proper staff regulations over the whole secretariat; it arises no less from the uncertainty of the political atmosphere and from the inconsistencies of national delegations. An urgent necessity in almost every department of the United Nations and the Specialized Agencies is a survey of the qualifications of temporary staff applying for permanent appointments, and all staff members should be given a definite decision either on the security of their jobs or on the date of their termination. The staff regulations of the United Nations also provide for filling vacancies by promotion rather than by an outside appointment, "with due regard to the maintenance of the staff on as wide a geographical basis as possible and without prejudice to the inflow of fresh talent at the various levels". All the awkward practical questions are left to be worked out; but most organisations have now developed a more or less clearly defined system of promotion. If these systems can be given adequate publicity, there should be less ground for dissatisfaction among those who might otherwise feel that their qualifications have been overlooked when senior posts fall vacant.

The broadsheet deals briefly with the general questions of co-ordination and notes the limited possibilities of interchange of officials between the United Nations and the Specialized Agencies, in spite of the undoubted advantages that a regular interchange would offer. The importance of staff consultation is also noted, but consideration of salary scales is deliberately omitted, important though this question is. Like some other matters which have been discussed, it bears closely on the important question of the morale of the secretariat staffs. This undoubtedly is not always as high as it should be; but even more than on the security factor, it depends on the conviction of each individual member of a secretariat staff that his job is worth doing. That, however, depends on the whole question of the functions of the secretariats and their relations with the policy-making bodies which are discussed in the second broadsheet.

Broadsheet No. 307 starts with a discussion of the general factors enhancing or limiting the influence which a secretariat may wield, and then examines in greater detail the part that can be played by a secretariat in the formulation of policy, in discussions at conference, in the preparation of budget estimates and in the execution of conference decisions. The broadsheet brings into clear relief some of the features which distinguish an international secretariat from a national Civil service, notably the fact that it serves a collection of governments, or government representatives, who lack a common tradition and a common outlook, and who meet infrequently. This situation affords a secretariat great scope for initiative, and it appears that many are already closely concerned in the making of policy. Here technical competence is a fundamental condition if the initiative of a secretariat is not to be ignored or regarded with suspicion.

The technical competence of an international secretariat, moreover, means not only efficiency in the usual sense but also the possession of a sound political judgment. *Planning's* observations on this particular point deserve careful attention from the many scientific workers who are now in one way or other concerned with the activities of the numerous international scientific bodies. A secretariat, P E P remarks, needs to be keenly aware of the wider implications of any problem under discussion and to be able to judge whether a possible proposal or suggestion is likely to be generally acceptable to governments.

That is true at other levels, as is the observation that a secretariat may frequently be in the best position to suggest alternative priorities to its policy-making organ, if this means suggesting the postponement of agreed projects. Experience drawn upon in this study leads *Planning* to suggest that intuition is not enough to enable a secretariat to distinguish between rashness and boldness, between a passion for immediate results and a disciplined enthusiasm. In the field of science, it is probably true that more harm has been done through the failure to provide a proper secretariat at all than from undue initiative on the part of such a secretariat. International scientific conferences, moreover, have on occasion suffered through being served by extremely amateur secretariats. Experience of the numerous permanent international scientific bodies now in existence should also induce those scientific men with experience of them to endorse the concluding remark of the broadsheet, that competence and sound judgment can be developed only if they are consciously pursued as objectives.

OPENING OF MILK BOTTLES BY BIRDS

IN 1921 birds described as tits were observed to prise open the wax-board tops of milk bottles on the doorsteps in Swaythling, near Stoneham, Southampton, and drink the milk. This is the first known record of an act which has now become a widespread habit in many parts of England and some parts of Wales, Scotland and Ireland, and which has to date been practised by at least eleven species of birds.

The spread of the habit is interesting, because of the problems of behaviour involved. How far did the individual birds learn the habit from each other, or invent it for themselves? If most of them learnt it, by what process did they do so? How did, and how do, they detect the presence of food inside the bottle?

These are the questions which James Fisher and R. A. Hinde pose in a recent article in *British Birds* (**42**, No. 11; November 1949), and although the writers agree that proper answers to the questions can be obtained only from carefully controlled experiments on birds of known history, it is submitted that much useful information can be derived from the collection of facts about the spread of the habit from members of ornithological societies and from the general public.

Some four hundred records have already been obtained about bottle-opening by species of tits, while to a lesser extent observations have also been made with house-sparrows, blackbirds, starlings, robins, chaffinches and hedge-sparrows.

Occurrence of the habit is naturally limited primarily by whether or not milk is distributed in bottles in the district. There is, however, good evidence in many cases that the habit may not develop in a district for several years after the use of bottles has become almost universal there—this is known to have been the case in at least twenty-

three out of thirty districts where the year in which milk bottles were actually introduced is more or less accurately known.

Most British tits, and certainly the British species known to open milk bottles, namely, the great tit (*Parus major*), the blue tit (*P. cæruleus*) and the coal tit (*P. ater*), are resident and do not normally move, even in winter, more than a few miles from their breeding place. It would seem, therefore, that new centres and records more than fifteen miles distant from any place where the habit has been recorded previously probably represent new 'discoveries' of the habit by individual birds. The distribution of the records is consistent with the view that the new source of food was actually discovered *de novo* by only a small proportion of a local tit population and then passed on in some way to other individuals. In England and Wales, it seems likely that the habit has arisen *de novo* at least once per vice-county and may have arisen more often than this. It might be argued that the pattern of distribution of the observations reflects simply the view of the observers. In densely populated areas there are, of course, more observers ; but there are, similarly, more milk bottles. Further, there are many densely populated areas from which no record of the habit has yet been received or from which negative records have been received. Moreover the time interval between the introduction of milk bottles and the first occurrence of the habit makes this argument unsound. The evidence that the area in which the habit occurred, as well as the actual number of records, increased more rapidly each year, is enough to support the view that when the habit has been acquired by one tit it can then be spread through the population by some form of imitation or learning.

Many observations have been made about the actual method of opening the bottles. Although the habit occurs throughout the year, it is more prevalent during the winter months than in the summer. This may be due to the increased need which the birds have for fats during severe weather ; but many observers record that tits are much more common in winter in urban areas than they are in summer, and this is of importance. The bottles are usually attacked within a few minutes of being left at the door. There are some reports of parties of tits following the milkman's cart down the street and removing tops from bottles in the cart while the milkman is delivering milk to the houses. The method of opening the bottles varies greatly. When the milk bottle is closed by a cap of metal foil the bird usually first punctures the cap by hammering with its beak and then tears off the metal in thin strips. Sometimes the whole cap is removed and sometimes only a small hole is made in it. Cardboard caps may be treated in a variety of ways. The whole top may be removed, or only the press-in centre, or the cardboard may be torn off layer by layer until it is thin enough for a small hole to be made in it ; the milk may be taken through this hole or the bird may insert its beak in the hole and flick off the remainder of the top. The records show that several different methods may be used in any one district, and that more than one method may be employed by one individual.

In many areas bottles containing milks of different grades are distinguished by having caps of different colours. No less than fourteen observers who had milk of more than one type delivered at the house reported that the tits attacked only bottles of one type, and four others reported an almost invariable preference for one type.

Without experimental evidence it is impossible to decide which senses are of use to the bird in indicating the presence of food. Several correspondents have found that bottles filled with water or even empty bottles are still attacked ; but this conveys nothing if the previous history of the birds is not known.

To what extent it would be correct to refer to the behaviour of those individuals which 'invented' the habit for themselves as 'insight learning' is a problem which cannot be resolved with the present inadequate data.

T. H. Hawkins

NEW "BRITISH STANDARDS" IN AGRICULTURE

THREE booklets* have recently been published by the British Standards Institution, each of which specifies standards in a particular field of agriculture. The first booklet, "Sampling Milk and Milk Products", was originally published in 1938 ; but improvements in sampling technique have made necessary a revision. The new version of the Standard emphasizes strongly the difficulty of obtaining an adequate sample of a bulk of material, especially if the bulk consists of a large number of small packages. Careful attention to details of the sampling is essential if the analytical results based upon the samples are to have any validity. Standard 809 : 1949 describes the techniques for obtaining samples from milk, cream, butter, cheese and other milk products, but is not concerned with the methods by which these samples are to be tested. That it contains no reference to the statistical aspects of the problem of sample selection is surprising ; for example, rules are given for the extraction of small samples from cheese, but no mention is made of the admittedly difficult problem of ensuring that the sample shall give an unbiased and reasonably precise estimate of the qualities measured.

The second booklet specifies performance tests intended to ensure a high standard for rubber used in milking machines, without placing restriction on the type of rubber, and to encourage uniformity between successive batches of rubber parts. The present version of Standard 1578 : 1949 relates only to natural rubber ; but it is intended to include synthetic rubbers in a revised version as soon as sufficient experience of them has been gained.

The increasing interest in the use of vitamin D_3 solutions for the enrichment of poultry mashes has made desirable the specification of standard solutions suitable for incorporation in poultry food. The new Standard 1581 : 1949, "Vitamin D in Oil for Poultry Feeding Purposes", recommends a sampling according to British Standard 627, followed by a biological determination of potency according to British Standard 911, in order to ensure that the vitamin D_3 content shall be either at least 200 B.S.I. units, or at least 400 B.S.I. units per gram. The Standard also describes the procedure to be adopted in the determination of acidity, for which an upper limit of 2 per cent (expressed as oleic acid) is specified.

D. J. Finney

* Sampling Milk and Milk Products (British Standard 809 : 1949). Pp. 20. 2*s.* 6*d.* net. Rubbers for Milking Machines (British Standard 1578 : 1949). Pp. 8. 2*s.* net. Vitamin D in Oil for Poultry Feeding Purposes (Types 200 and 400) (British Standard 1581 : 1949). Pp. 10. 2*s.* net. (London : British Standards Institution, 1949.)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Production of Amino-acids in Synthetic Media by *Escherichia coli* and *Aerobacter aerogenes*

STUDIES of the effect of glutamate and aspartate on the lag phase[1,2] and the early logarithmic phase[3] of *Escherichia coli* and *Aerobacter aerogenes* growing in a basal glucose – ammonium salt medium have suggested that these amino-acids and related non-nitrogenous compounds are important as intermediates necessary in cell division. This function is also emphasized by the work of Lwoff and Monod[4] and Ajl and Werkman[5], who have studied their use to replace the carbon dioxide requirement of bacteria growing in synthetic media. Morrison and Hinshelwood[1], using paper chromatography, have reported traces of glutamate and aspartate, in cultures through which air of normal carbon dioxide content was bubbled, after an approximate ninety-fold concentration of the liquid.

We now wish to report that the presence of amino-acids can be shown, without previous concentration, in filtrates from *E. coli* and *A. aerogenes* grown in unaerated conditions; for aerated cultures the quantities were considerably reduced. The presence of relatively large concentrations of salts in the synthetic medium renders difficult the direct identification of the amino-acids under these conditions, however. On concentrating ten times and adding an equal volume of ice-cold ethanol, most of the salt was removed, with the loss of some ninhydrin-positive material, and it was then possible by means of paper chromatography to demonstrate the presence of glutamic acid. The investigations were then extended by evaporating down to dryness, under reduced pressure on a water-bath, 1 litre of filtrate from a culture of *E. coli* grown without aeration in the glucose–ammonium salt medium. The residue was ground up with a glass rod under cold ethanol (20 ml.) and the amino-acid solution so obtained was examined. A chromatogram is shown in Fig. 1. By 'marking' with known amino-acids as well as by two-dimensional chromatography using acetic acid – butanol and pyridine – butanol mixtures, it was shown that spot *A* probably contains histidine, *B* aspartic acid, *C* glutamic acid and *D* alanine.

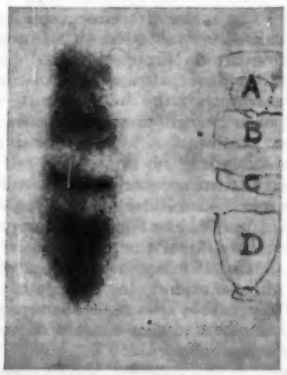

Fig. 1. Relevant portion of paper chromatogram of ethanolic extract of residue of filtrate from *E. coli* culture in glucose–ammonium salt medium. Solvent: butanol–acetic acid

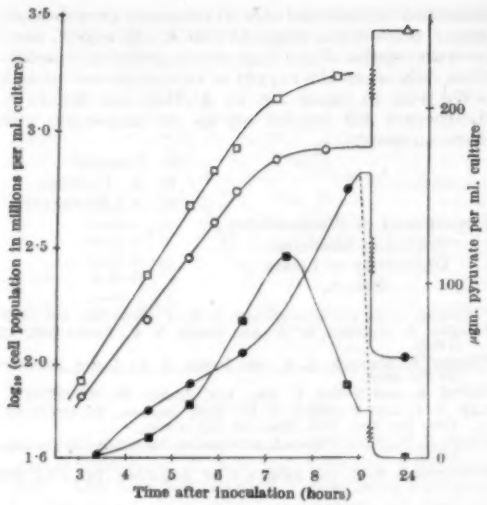

Fig. 2. Pyruvic acid production of *A. aerogenes* during growth in glucose – ammonium salt medium. Aerated: □, log (cell population); ■, pyruvate concentration. Unaerated: ○, log (cell population); ●, pyruvate concentration. Aeration at 9 hr. of previously unaerated culture produced increase in stationary population indicated by △ and fall in pyruvate concentration shown by dotted line

In these experiments filtrates were examined in the early stationary phase of the bacteria, and the colour developed with ninhydrin was most marked when ammonium salt was present in excess of growth requirements. It has been established[6] for *E. coli* that deamination of some amino-acids is an aerobic process, and the difficulty of proving their presence on aeration may be due to the fact that in such cultures equilibrium in the stationary phase would be in favour of the formation of the keto-acids from which they are derived. We have accordingly examined the production of pyruvic acid, the main keto-acid present, during growth of *A. aerogenes* with and without aeration. The toluene extraction method was used[7], which is highly specific for pyruvic acid, and the results are shown in Fig. 2. It is seen that although the amount of pyruvate increases during the growth of an aerated culture, it falls fairly rapidly to zero as the stationary phase begins. The level of pyruvate reached in an unaerated culture is higher and the fall in concentration in the stationary phase is much less pronounced. If such a culture is aerated, however, the pyruvate disappears.

It would appear, therefore, that aeration favours not only the deamination of certain amino-acids, but also the destruction or utilization of their corresponding keto-acids. This may be related to our observation that, when the glucose in the basal medium is replaced by pyruvate or α-keto-glutarate (or by malate or succinate), the stationary population reached by our strain of *A. aerogenes* in unaerated cultures is much less than when aeration is provided. Increased crops on aeration have been reported for a variety of media, and have sometimes been ascribed to the oxidation and removal of toxic products accumulating when air is absent. The present work, together with our observation[3] that filtrates from

unaerated cultures are able to stimulate growth when oxygen is available, suggests that *E. coli* and *A. aerogenes* are capable of utilizing certain products of metabolism only when the supply of oxygen is maintained.

We wish to thank Dr. D. A. Hall and Mr. E. S. Holdsworth for helpful advice in connexion with chromatography.

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Biochemical and Nutritional Significance of the Reaction between Proteins and Reducing Sugars

It has long been known that amino-acids and reducing sugars react when heated together in concentrated aqueous solution (the Maillard reaction), probably first by interaction between the amino- and aldehyde-groups, and afterwards by a complicated series of changes leading to darkening, evolution of carbon dioxide and the formation of tarry products. A similar kind of reaction occurs with proteins, and we have recently been able to isolate the first stage of the process and to demonstrate that, under very mild conditions (approximately 13 per cent moisture, neutral *p*H and 37° C.), as much as 7 per cent of reducing sugar can be firmly bound to a protein—almost entirely at the free amino-groups—without impairing its colour or solubility.

The biochemical properties of such protein-sugar complexes have not so far been examined in any detail, nor has it been ascertained whether or not they occur pre-formed in Nature. The possibility of the existence of amino-sugar linkages of this type in mucopolysaccharides, mucoids and glycoproteins, however, cannot be ignored, and there is no doubt that they can readily arise as artefacts during the handling or storage of materials of biological origin. A fall in free amino-nitrogen believed to result from an amino-sugar interaction has, for example, been reported during the storage of a concentrated liver extract rich in free amino-groups and glucose[1], and the amino-sugar complexes are known to give an Ehrlich reaction with *p*-dimethylaminobenzaldehyde similar to that given by the N-acetyl hexosamines[2,3], as well as to reduce dyes such as the 2 : 6-dichlorophenolindophenol used for the estimation of ascorbic acid. On such grounds alone the reaction is worthy of wider study.

The protein– (or amino-acid–) sugar reaction has been shown to be of great importance in the chemistry of food, and is now believed to contribute to many changes, some desirable, some undesirable, during cooking, processing and storage. Effects of practical significance as evidenced by the storage of skim-milk powder[4] include the development of unpleasant flavours and of brown discoloration, and loss of biological value of the protein. The fact that the reaction has a high temperature coefficient and proceeds most rapidly when the reactants are in equilibrium with an atmospheric relative humidity of 65–70 per cent[5] makes deterioration of this type of particular significance in dried and concentrated foods and in warm climates.

In our investigation of the mechanism of the reaction, a solution of sodium caseinate and glucose at *p*H 6·3 was freeze-dried, and the finely divided product (containing 31 per cent glucose on the dry basis) held at 37° C. in equilibrium with an atmosphere at 70 per cent relative humidity. Three stages of interaction could be distinguished.

(1) During the first stage the free amino-groups of the protein (consisting mainly of the ε-amino-groups of the lysine side-chains) reacted rapidly with the glucose, leading to a ratio of glucose bound to amino-groups destroyed of but little more than 1 : 1. After five days, approximately two-thirds of the amino-groups had reacted and the product was still white and of unimpaired solubility. The powerful reducing properties of the product and the fact that none of the glucose could be recovered by acid hydrolysis shows that the glucose-amino-group linkage cannot be that of a simple N-glycoside. Isomerization of a first-formed N-glycoside to an *iso*glucosamine (with a mono-substituted amino-group at carbon 1 and a carbonyl group in position 2) by the Amadori rearrangement[6] would explain the reducing properties and resistance to hydrolysis of the complex, and part at least of its behaviour with the Ehrlich reagent; but such a suggestion at present can only be speculative, and the precise structure of the complex still awaits elucidation.

(2) As the reaction continued, progressively more carbohydrate combined with the protein than could be accounted for by combination with free amino-groups, and other of the 'essential' amino-acids in addition to lysine became involved. After thirty days, when the protein-sugar complex had become somewhat brown in colour and of low solubility over a wide *p*H range, approximately 90 per cent of the lysine, 70 per cent of the arginine and 30 per cent of the histidine were shown to have reacted. Approximately a half of the methionine and one-third of the tyrosine had probably also disappeared. Hydrolysis by acid liberated all the combined methionine, most of the tyrosine and 70 per cent of the lysine, but none of the arginine or histidine. There was no demonstrable loss of tryptophane or of total acidic or amide groups. Total basic groups estimated by dye-absorption or alcohol-titration were practically unchanged, the basic group–sugar combination apparently still possessing basic properties. Cystine and glutamic acid estimated after acid hydrolysis also showed no change.

(3) On still further storage the colour of the reaction-mixture became darker, dialysable products (non-glucose) appeared in increasing quantities, and the increase in weight of the protein tended towards a maximum. After 164 days, approximately one-third of the total glucose undergoing change had been converted into dialysable decomposition products, and the protein–sugar complex contained nearly 20 per cent of bound carbohydrate.

At all stages of the reaction the increase in weight of the protein was approximately sufficient to allow for condensation of one molecule of glucose with each

amino-acid side-chain inactivated; but no direct evidence has been obtained that this is, in fact, the method of combination. The exact nature of the groups combined with the various amino-acid side-chains, therefore, still remains to be determined. They could be (*a*) glucose itself, (*b*) reactive decomposition products of glucose or of the glucose-amino complex, or (*c*) cross-linkages with carbohydrate already attached to the amino-groups of the protein.

The experimental conditions used in this work were those shown to give a maximum rate of disappearance of the free amino-groups[5,7], the water and glucose contents being consistent with a picture of the reaction as taking place in a monolayer at the surface of the protein. At higher water-contents, degradation and browning are accelerated, and this may well account for the failure of other workers to distinguish the earlier stages of the reaction.

The work described above was carried out as part of the programme of the Food Investigation Organisation of the Department of Scientific and Industrial Research.

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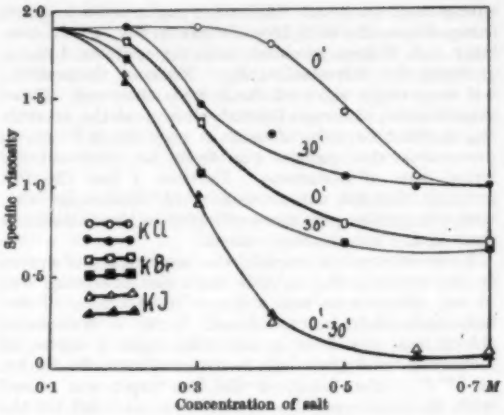
Effect of Halogen Ions on *F*-Actin

I HAVE investigated the behaviour of polymerized actin in different concentrations of potassium chloride, bromide and iodide respectively.

The actin was prepared in the following way. Rabbit muscle was minced and the myosin extracted with acid potassium chloride–phosphate[1]. The muscle residue was washed in an equal volume of distilled water and suspended in five volumes of 0·4 per cent sodium bicarbonate at room temperature. After 30 min. it was pressed through a cloth and kept overnight in a refrigerator at −12° C. Then it was suspended in an equal volume of acetone and pressed through a cloth. It was stirred again in an equal volume of acetone and allowed to stand for 10 min. The acetone was removed by pressing through a cloth and by drying at room temperature. The actin was extracted from the muscle residue following the method of F. B. Straub[2]. The water solution obtained by this method contained 7 mgm./ml. actin in the globular form. When the salt concentration was brought to 0·1 *M* after standing for 15 min. at room temperature, it was entirely polymerized, being transformed to *F*-actin. The *p*H of the solution was 1.

The polymerized actin was cooled to 0° C. Samples were taken out and their salt concentrations brought to 0·3, 0·4, 0·5, 0·6 *M* with potassium chloride, bromide and iodide respectively. Determinations were made immediately after the salt concentration was adjusted, and again 30 min. later. Meanwhile, the



samples were allowed to stand at 0° C. The qualitative double refraction of flow and viscosity were examined. The modified Ostwald viscosimeter was used[3]. It was found that double refraction of flow and viscosity decrease with increasing salt concentration. This increase is most obvious using the iodide ion, where the double refraction of flow disappears when the concentration of salt reaches 0·5 *M* and the viscosity drops almost to the viscosity of the pure salt. Results of the measurements are shown in the accompanying graph.

Each anion examined is able to polymerize actin in 0·1 *M* concentration. As shown by the graph, the disintegrating effect of iodides is instantaneous, as proved by the disappearance of double refraction of flow. If we remove the salt by dialysis, polymerized actin is transformed into the globular form. This transformation is reversible. Iodide-treated actin, however, after being dialysed, cannot be transformed again into its *F*-form. The disintegrating effect of halogen ions is probably connected with their oxidizing properties[4].

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Vitamin B_{12} and Histamine

SINCE evidence has been accumulated that a release of histamine, or histamine-like substances, accounts, completely or partially, for anaphylactic shock in animals[1], an attempt has been made to find out whether vitamin B_{12}, which has been shown to possess a protective action on anaphylactic shock in the guinea pig[2], could also have an anti-histaminic activity. Vitamin B_{12} has therefore been tested on guinea pigs in which a histaminic shock was provoked; as source of vitamin B_{12}, 'Rubramin' (Squibb) vials of 15 γ have been used.

Of twelve guinea pigs (mean weight 300 gm.) four, used as controls, were injected intracardiacally with 0·12 mgm. of histamine (which is almost twice the M. L. D. of 0·025 mgm. per 100 gm. body-weight by intravenous injection[3]), and all of them died of shock

within half an hour. The other eight were injected intraperitoneally with 15 γ of vitamin B_{12}, and 15 min. later each of them received, as in the controls, 1 mgm. of histamine intracardiacally. None of them died; but very slight signs of shock were observed. These experiments, although limited, show that the vitamin B_{12} is effective, even if used in very small doses, in protecting the guinea pig from an undoubtedly lethal dose of histamine. Further, I had the impression that the same quantity of 'Rubramin' was, with the guinea pig, more effective in the histaminic than in the anaphylactic shock.

In an attempt to explain the mechanism of action of the vitamin B_{12} in this case, the first step was to see whether or not a direct inactivation of the histamine might be considered. 1 c.c. of 'Rubramin' (15 γ) was mixed in a test-tube with 1 mgm. of histamine, and then left in an incubator for 24 hr. at 37° C.; also 1 ml. of distilled water was mixed with the same quantity of histamine and left for the same time in an incubator at the same temperature. This solution was used as control. Strips of guinea pig intestine were placed in a Tyrode bath at 37° C. and connected with a Marey drum to record contractions. These strips of intestine so prepared failed to show any appreciable difference in contraction response when either the vitamin B_{12}–histamine solution or the distilled water–histamine solution was added. Hence I am inclined to rule out any direct inactivation of the histamine by vitamin B_{12}; for otherwise the solution containing vitamin B_{12} should have given a much-decreased contraction response.

Another possibility is activation of the histaminase by the vitamin B_{12}. That pre-treatment with histaminase can prevent anaphylactic shock in the guinea pig has been shown (Karady and Browne[4]), although not confirmed by Alexander and Donald Bottom[5]. Eight guinea pigs were therefore sensitized with 1/10 horse serum intraperitoneally. After fifteen days, they were given 30 γ of vitamin B_{12} intraperitoneally and immediately afterwards 0·3 gm. of sodium benzoate intramuscularly. (The sodium benzoate was given because it has been shown[6] to inhibit histaminase completely at the concentration of 0·1 per cent.) Finally, fifteen minutes later, the shock-producing injection of 1 ml. of horse serum was given. All the guinea pigs survived, showing only slight signs of shock.*

These results indicate that the vitamin B_{12} does not activate the histaminase; indeed, if this were the case, the injected sodium benzoate inactivating the histaminase should have annulled the protective action of the vitamin B_{12}, and the guinea pigs should have died of anaphylactic shock. Since 'Rubramin' seems to act on the histamine neither directly nor indirectly by interference with its metabolism, its mechanism of action seems to be competitive antagonism as in the case of the common antihistaminic drugs.

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Dispersion of the Birefringence in Barium Titanate

THE birefringence of barium titanate has been measured over the range 4000–7000 A. Our attention was first directed to this work by the impossibility of obtaining the correct colour sequence in compensation methods of measurement, and the disagreement of birefringence values calculated from the apparent compensation points and those found by other methods[1].

The crystals used were of the flat-plate type with dimensions of the order 0·5 × 0·5 × 0·1 mm., containing a single twin boundary running parallel to the plate edge and at 45° to the larger surface. When viewed between Nicols crossed at 45° to their edges, the crystals exhibit a system of fringes on the twin boundary, marking out contours of equal relative retardation. The area with *c*-axis (optic axis) perpendicular to the plate is effectively isotropic, and thus always appears dark.

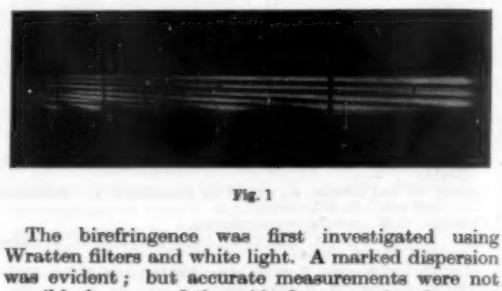

Fig. 1

The birefringence was first investigated using Wratten filters and white light. A marked dispersion was evident; but accurate measurements were not possible because of the wide frequency-band passed by these filters.

To overcome this difficulty, the overlapping coloured fringes obtained in white light were analysed by a grating spectrometer. The method is similar to that of 'crossed dispersion' in interferometry[2]. Light from a carbon arc was focused on the crystal, which was clamped on the stage of a projecting microscope between crossed Nicols in the 45° position. The crystal was oriented by rotation of the stage to produce a horizontal fringe system, which was focused on the vertical slit of a grating spectrograph.

A typical spectrogram is shown in Fig. 1. The number of fringes increases rapidly from the red end of the spectrum, fresh fringes running in from the birefringent side of the twin boundary. With suitable corrections for variation in magnification of the microscope with frequency and distortions in the

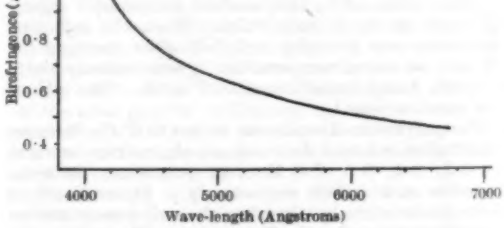

Fig. 2

subsequent enlargements, the birefringence can be calculated from the fringe separation, a helium spectrum being used to calibrate the grating dispersion.

From the shape of the birefringence – wave-length curve (Fig. 2) there would appear to be an absorption frequency at about 3800 A.

Further work is in progress to extend the range of the measurements to the ultra-violet.

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Aperiodic Frequency-Doubling by Means of 'Pluri-Terminal' Titanate Capacitors

As is well known, titanate ceramic dielectrics show a pronounced dependence of permittivity upon applied A.C. or D.C. field-strength, due to dielectric saturation and hysteresis.

We felt that this permittivity variation should exist not only for superimposed fields having the same direction as the original 'measuring' field, but also for fields applied at right angles. We have been able to confirm this assumption by means of a new four-terminal capacitor element, which consists of a small cube or parallelepiped of titanate ceramic, four (or all) faces of which are partially metallized. Pairs of opposite electrodes may be considered as independent capacitors which can be energized by separate voltage sources.

Measurements were made for the two alternative cases: (*a*) *crossed fields:* one pair of electrodes connected to the measuring device (for example, a conventional Schering bridge); the other orthogonal pair receiving the variable A.C. or D.C. voltage; (*b*) *parallel fields:* the variable polarizing voltage is impressed on the same pair of electrodes used for measurement, leaving the second pair disconnected.

The experimental results show that the capacitance variation as a function of the applied voltage has substantially the same order of magnitude in both cases.

To cite a typical example among the various practical applications of non-linear, pluri-terminal capacitor devices, we have developed an aperiodic frequency-doubling circuit. The basic circuit diagram using a four-terminal titanate capacitor is represented in Fig. 1. Applying to the input electrodes a voltage of suitable frequency and increasing this voltage beyond a critical value, one observes in the output electrodes an increasing second-harmonic distortion. Impressing now a D.C. polarization of suitable value upon the element, a nearly complete suppression of the fundamental frequency is obtained without filtering, and the second harmonic attains a good sinusoidal waveform.

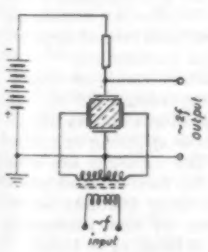

Fig. 1

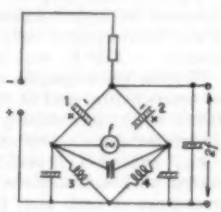

Fig. 2

Obviously the frequency-doubling depends upon the second-harmonic distortion caused in the non-linear circuit elements by the D.C. polarization; this may be more easily understood by considering the circuit as a four-arm bridge including the stray capacitances between adjacent electrodes, as shown in Fig. 2. If the bridge is balanced, the current of fundamental frequency disappears in the output; but the double-frequency current does not, because the D.C. polarization in branches 1 and 2 is of opposite sign.

Although the frequency-doubling was originally demonstrated with four-terminal capacitors, it can also be obtained just as well with three-terminal elements (in the form of disks, plates or tubes) and even with two separate two-terminal elements.

Frequency-doubling could be obtained also when the D.C. polarization was temporarily applied and then removed. Since the delay time is quite large, it is possible to apply the polarizing voltage in the form of pulses or as a practically static charge. The above-mentioned results have been partly communicated in a paper read at the National Convention of the Institute of Radio Engineers held at New York in March 1949.

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Superconductivity of Uranium

Following Justi's discovery[1] of the superconductivity of uranium at 1·3° K., one of us[2] found, on the basis of magnetic measurements, that a specimen of pure uranium did not become superconducting down to 1·08° K., and suggested that Justi's results, which were based on resistance measurements, were due to traces of a superconducting impurity. It is now probable that this interpretation is incorrect, in view of the following new results.

Alekseevski and Migunov[3], also using the magnetic method, found that some uranium specimens became superconducting at 1·3° K., but that less pure specimens did not, down to the lowest temperature tried. This led us to examine a wider variety of specimens by the magnetic method, and we did indeed find that one sample became superconducting at about 1·3° K. (the transition was spread over about 0·2° K.), though this was *less* pure than the samples which did not become superconducting. More recently, we have taken two of the specimens which failed to become superconducting in the helium-range down to lower temperatures by the adiabatic demagnetization technique, using the method developed by Mendoza[4], and found that they both became superconducting at about 0·75° K., the transition again being spread over about 0·2° K. It therefore seems probable that uranium is indeed a superconductor, but has different transition temperatures according

to the purity of the specimen. The recent results of Heer and Daunt[5] point to a similar situation for titanium.

In the course of the experiments, it was found that rather large magnetic fields (of order 2,000 gauss per deg. K. below the transition temperature) were required to destroy the superconductivity of all the samples. The destruction was spread over a wide range of fields, and the detailed magnetization curve varied from one sample to another, so the figure quoted is only an order of magnitude. If such high fields were true thermodynamic critical fields, and varied with temperature in the usual parabolic way, the electronic specific heat of normal uranium at low temperatures would have to be as high as 8,000 T ergs/gm./° K. Some rough measurements of the specific heat between 1° K. and 4° K. suggest that the electronic specific heat is at most 600 T ergs/gm./° K., so it is probable that the observed high fields are not, in fact, true critical fields, but of the same nature as the apparent high critical fields of impure superconductors.

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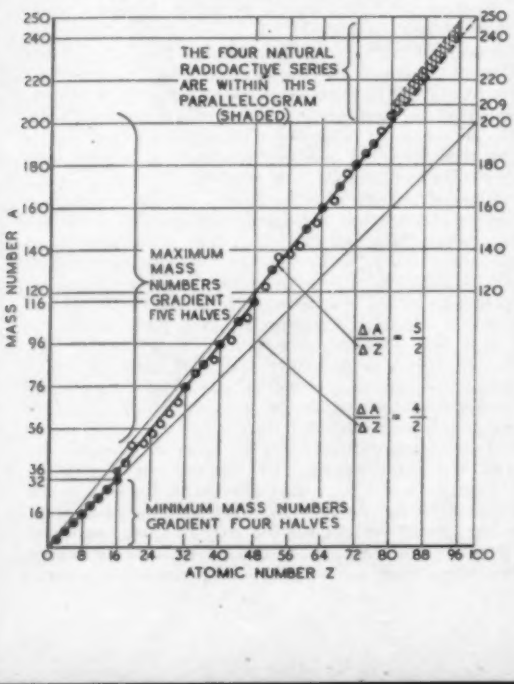
Maximum Mass Numbers of Stable Nuclei

The importance of the maximum mass number of a stable nucleus resides in its obvious correlation with the structure of completed nuclear shells.

When mass numbers of nuclei are plotted, as in the accompanying diagram, against their atomic numbers, two reference lines may be drawn, radiating from zero, one with a slope of two, and the other with a slope of five halves. From $Z = 0$ to $Z = 16$, the *minimum* stable isotopes have, as is well known, a gradient of exactly 2, and from $Z = 16$ to $Z = 72$ the *maximum* stable isotopes have a gradient of five halves.



There are sudden and significant discontinuities of four mass units at $Z = 16$, 48 and 80. Also, at $Z = 72$, the gradient changes temporarily from five halves to six halves.

The range $Z = 80$–96 embraces all the heavy natural radioactive elements, and the line of maximum mass numbers retains its gradient of five halves with a maximum difference of nine units above the reference line.

The general geometry of the data is clearly shown in the diagram. The most striking feature is the retention of the gradient of five halves, which demands that for an increment in Z of 2 units of charge, there is an increment of A of 5 units of mass. As two of the mass units are necessarily protons, the other three mass units must be neutrons.

It would appear reasonable to infer that a saturation field may exist between an alpha-particle and a neutron.

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Structure of Monoxides of some Transition Elements at Low Temperatures

It has been shown by one of us[1] that, at ordinary temperatures, the structure of nickel oxide is slightly deformed from face-centred cubic symmetry. Later work[2] proved that at − 180° C. an increase in the rhombohedral deformation occurs. On the other hand, it was found that the departure from cubic symmetry vanishes at a temperature of about 200° C.

X-ray powder photographs of the monoxides of iron and cobalt disclose no abnormal structural features at room temperatures. Recently, abnormalities in the structure of a mixed monoxide of nickel and cobalt have been noticed, and it was thought desirable to examine the behaviour of this monoxide and of the monoxides of cobalt, iron and manganese at low temperatures. Some interesting changes have been observed.

In order to carry out the investigation, a 19-cm. diameter powder camera of the conventional type has been modified, and the principle devised by Lonsdale and Smith[3] applied to obtain complete X-ray powder photographs at liquid-air temperature. Slight changes of the equipment enabled photographs to be obtained at approximately − 70° C. An extension of the technique to include a temperature of approximately − 110° C. was also tried successfully.

Powder photographs of cobaltous oxide at liquid-air temperature and at room temperature (20° C.) are shown in the accompanying reproduction. At liquid-air temperature all reflexions show splitting or multiplicity except 111 and 222. The changes are consistent with a transition from the face-centred cubic arrangement such that the symmetry becomes tetragonal. The lattice parameters of the tetragonal structure cell are $a_0 = 4{\cdot}2552 \pm 0{\cdot}0005$, $c_0 = 4{\cdot}2058 \pm 0{\cdot}0005$ kX., $c/a = 0{\cdot}9884 \pm 0{\cdot}0001$ at − 180° C.

X-ray powder photographs (cobalt $K\alpha$ radiation, 19-cm. camera) of cobalt oxide: upper photograph, at 20° C.; lower, at −180° C.

There is a measurable structural deformation at −70° C., but the axial ratio of the tetragonal cell is only 0·995, thus differing from the 1·0 of a cubic cell by a smaller amount than at − 180° C. At 20° C. the face-centred cubic cell had a lattice parameter $a_0 = 4{\cdot}2495 \pm 0{\cdot}0005$ kX.

The X-ray examinations of ferrous oxide disclose a rhombohedral deformation of the face-centred cubic arrangement below − 70° C. The deformation thus takes a similar form to that found for nickel oxide, but the angle of the unit rhomb becomes less than 60° instead of greater.

Manganous oxide also shows below − 100° C. a transition from face-centred cubic to a symmetry approximating to rhombohedral; the deformation at − 180° C. is substantial.

It is hoped to describe this work in more detail elsewhere. Further investigations should yield some explanation of the changes in structure, which appear likely to be connected with the particular electronic configuration of the transition elements.

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Point Sources of Radio Noise

One of the unexplained phenomena of radio-astronomy is the existence of intense point sources of noise. These have been associated with the galaxy because they seem to be point sources within the accuracy of measurement, and because they have not shown pronounced parallax or proper motion. But the assumption of galactic or stellar origin fails to explain all the facts as understood now.

In the first place, although several point sources lie in the galactic plane, others are located at high galactic latitudes. Examples of these latter are the point sources in Hercules and in Coma Berenices. Furthermore, of the sources that lie approximately in the galactic plane, none has been definitely identified with optical objects, and none lies in the direction of the galactic centre.

Another major difficulty with the stellar or galactic hypothesis is the inverse-square decrease of intensity with distance from the source. For example, a source at the distance of the nearest star would have to radiate at a rate exceeding that of the sun by a factor of 10^{10} in order to produce the same noise intensity on the earth.

This last objection suggests that we should look within the solar system for the origin of these radio-noise sources. We must rule out the planets and asteroids as possible sources, if only because they are concentrated in the plane of the ecliptic and have huge proper motions and parallax angles. Giant comets, however, having distant aphelia, constitute a remotely possible explanation of the point sources. Their orbits may have almost any inclination to the plane of the ecliptic and hence to the plane of the galactic equator.

Recent solar studies indicate the existence of extreme ultra-violet and X-radiation, which would have an ionizing effect on gaseous media. A rough calculation shows that if the ionizing radiation from the sun were absorbed by a distant comet—at, say, 50 astronomical units—and re-radiated over a 1,000 Mc./sec. band, the resultant radio-noise intensity on the earth would be consistent with the observations. We very tentatively suggest that plasma-type oscillations of a gaseous ionized medium might be a mechanism for the conversion of the solar energy to the observed radio-frequency noise.

If comets are the point sources in question, only the very largest, long-period ones will fit the observations. Even so, it may be possible to observe an annual parallax of the order of 1", and possibly also a small proper motion. We admit that this idea is highly speculative; but fortunately it is subject to direct experimental test. Detection of a measurable parallax would constitute a sufficient and necessary proof that the point sources of extra-terrestrial radio noise are part of the solar system.

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Induced Grid Noise and Noise Factor

It is easily shown that for any type of internal structure the power-frequency spectrum $s_g(f)$ of the current fluctuations appearing at the control grid of a triode valve is related to the spectrum $s_a(f)$ of the anode current fluctuations by

$$s_g(f) = \left| \frac{Y_g(f)}{g_m(f)} \right|^2 s_a(f), \qquad (1)$$

where $Y_g(f)$ is the increase, from the 'cut off' to the working conditions, of input admittance at the grid with the anode effectively earthed; g_m is the high-frequency mutual conductance of the triode. In the case of the 'induced' (transit-time) grid noise, and for moderate angles, the relevant component of grid admittance is largely susceptive, being

$$Y_{gi}(f) \doteqdot jB_i(f) = j.2\pi f.C_i,$$

where C_i is the value of the 'space-charge capacitance' measured on the valve. Thus, setting

$$s_a(f) = 2eI_a\Gamma^2$$

$$s_g(f) \doteqdot \left| \frac{j.2\pi f.C_i}{g_m} \right|^2 . 2eI_a\Gamma^2. \qquad (2)$$

The modifications to (2) introduced by distribution of electron velocities and trajectories are discussed elsewhere[1], and direct experimental verification is also described.

Applying (1) to the problem of noise factor of the common cathode triode, and assuming that all induced grid noise is correlated with cathode-anode shot noise, it is found that the minimum noise factor obtained on adjusting conductive and susceptive components of the 'source' (grid-ground) admittance is independent of cathode and anode lead inductance effects, space charge capacitance, transit-time damping and induced grid noise itself. Thus a circuit adjusted for minimum noise factor in the absence of these effects will function optimally when they are present. Such effects merely modify the input, output and transfer admittance of the stage without, to first order, affecting its noise factor.

We may immediately deduce, and it may be shown more formally, that in this hypothetical case the 'optimum detuning' at the grid required to minimize the noise factor is almost precisely the value of the space-charge capacitance C_t. In practice, the actual detuning required is found experimentally to be about 0·9 C_t. This discrepancy is due to the distributed nature of the correlation between induced grid currents and anode currents, the effects of which are generally explained by an artificial resolution of grid noise into completely correlated and completely uncorrelated components. The small deviation from C_t observed indicates that the 'uncorrelated' component is a small fraction only of the total induced grid noise, and need only be taken into account where great accuracy in estimation is required. Experiment shows that deviation of noise factor from values predicted from the simple treatment is detectable only in the region of operation where the grid is just about to take direct current, being then of the order of one or two per cent.

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[1] Bell, R. L., *Wireless Eng.*, [27 (March 1950)].

Truncated Normal Distributions

The lognormal frequency distribution, a type of normal curve in which the abscissal scale is logarithmic instead of linear, is of very wide occurrence in many branches of pure and applied science[1]. A special case is the truncated lognormal distribution, recently noted in insect populations by Spiller[2]. I have found several instances of this distribution in ecological and bacteriological studies, and also in examples of accident statistics and word distributions given by Yule[3]. As the existence of this large class of distributions becomes more widely known, so will simple methods of dealing with them be required.

With frequency counts of Spiller's type, where negative values cannot occur, those observations which would normally be negative swell the total of zeros. The distribution is then truncated, with a discontinuity at the point of truncation. The only method of preventing truncation is to increase the size of the sampling unit so that zero values occur very rarely or not at all, in which case the distribution may be taken as a complete lognormal curve.

Mathematically, the frequency function of such a distribution (where x is assumed to vary continuously) takes the form

$$\left.\begin{aligned} y &= 0, && x < a \\ &= \frac{1}{\sigma\sqrt{2\pi}} \int_{-\infty}^{a} \exp\left[-\frac{(x-\mu)^2}{2\sigma^2}\right] dx, && x = a \\ &= \frac{1}{\sigma\sqrt{2\pi}} \exp\left[-\frac{(x-\mu)^2}{2\sigma^2}\right], && x > a \end{aligned}\right\} \quad (1)$$

where $x = a$ is the point of truncation and μ, σ are the parameters of the parent normal curve. For discrete lognormal variation (with $\log(n+1)$ as the normalizing function to enable zeros to be plotted), the frequency of n counts per sampling unit can be written

$$y_n = \frac{1}{\sigma\sqrt{2\pi}} \int_{\log n}^{\log(n+1)} \exp\left[-\frac{(x-\mu)^2}{2\sigma^2}\right] dx. \quad (2)$$

For x greater than or equal to the point of truncation, the cumulative distribution function of (1) and the derived form (2) is the cumulative normal curve, which by definition becomes graphically a straight line when probits are taken as ordinates. For any practical distribution the best-fitting straight line to the cumulative observations estimates μ and σ, the mean and standard deviation of the parent normal curve. Objections to this method are that the accuracy of eye-fitted lines is always doubtful, and since successive points are not independent, probit regression methods are not applicable, and tests of significance are invalidated. Bliss[4] treats cases of truncation in time – mortality curves by computing corrections to preliminary graphical estimates; the objection relating to significance tests still holds, however, by reason of the non-independence.

An alternative method, which will be presented more fully elsewhere, is to equate the moments of the sample distribution to those of the theoretical model (1). These latter can be expressed in terms of μ, σ and a, and hence μ and σ may be found directly, obviating the necessity of transforming to probits and fitting straight lines. When applied to Spiller's distribution of red scale, this method gives values of 0·70 for μ and 0·55 for σ. A comparison of observed and expected frequencies is presented in the table, and the resulting value of χ^2 of 17·45 with 18 degrees of freedom has a probability of 0·50. There is thus no reason to assume any departure from normality in the sample.

No. of scales per leaf	Observed frequency	Expected frequency	No. of scales per leaf	Observed frequency	Expected frequency
0	89	73	10	13	18·1
1	79	95·7	11–12	31	30·2
2	78	78·1	13–14	29	23·2
3	58	62·3	15–17	24	26·7
4	51	50·9	18–20	19	19·7
5	30	40·7	21–25	28	23·2
6	39	34·3	26–35	30	26·5
7	34	28·6	36–50	20	22·2
8	27	24·5	51–	23	21·2
9	18	21·1			

Finney's[5] comments on Spiller's letter suggest that he has missed the implications of truncation. Truncation has the effect of raising the mean and lowering the standard deviation, the values quoted by Finney illustrating this; his graphical estimates are 0·70 and 0·53 for the parent curve, as compared with 0·774 and 0·487 from the original distribution. The two sets are not comparable for the purpose of testing agreement with the hypothesis of normality. Again,

the criterion of size of mean relative to standard deviation does not apply to a truncated curve, as would be the case with a complete normal curve.

The technique explained briefly in this communication offers a solution to the problem of truncated normal distributions, and is preferable to the use of regression or iterative methods employing probits, both on the score of ease of analysis as well as ease of interpretation.

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Heat-Flow Below the Oceans

Prof. Hans Pettersson has reported[1] measuring the geothermal gradient at two places in the deep-sea sediment below the Pacific Ocean. This work, done from the schooner *Albatross* of the first Swedish Deep-Sea Expedition, is apparently the first of its kind and is an important contribution to the study of the heat flowing from the interior of the earth.

As is well known, the amount of heat flowing across a plane surface in a thermal conductor is

$$h = -k \frac{\partial T}{\partial n},$$

where k is the thermal conductivity of the conductor and $\partial T/\partial n$ is the temperature gradient normal to the surface. During the past ten years, careful work has been done on the problem of determining the heat-flow to the surface of the *continents*. This is accomplished by measuring both the temperature gradients and the thermal conductivities of rocks of the same locality. It is beginning to appear from this work, carried out for South Africa[2], Britain[3], Persia[4], California[5] and elsewhere, that a normal heat-flow for a quiet (that is, non-volcanic) region of a continent lies in the neighbourhood of $h = 1{\cdot}2 \times 10^{-6}$ cal./cm.^{2}-sec., with likely departures of plus or minus about 20 per cent.

However, so far nobody has measured the heat-flow below the bottom of the oceans. It has been suggested[6] that this may be significantly less than the continental values, owing to the supposed partial or complete absence under the oceans of the granitic layer, the radioactive content of which evidently supplies a considerable fraction of the continental heat-flow. Prof. Pettersson, in solving the difficult problem of measuring the temperature gradient in deep-sea sediments, has made it possible to begin to determine heat-flow below the oceans. His two values of 22 and 26 metres per degree Centigrade give an average geothermal gradient of about 42° C./km., which he says is unexpectedly high[1].

It is true that this value would be somewhat high for a continent, but it has been shown in the past that heat-flow in the continents is considerably more uniform than either the conductivities or the geothermal gradients. For example, the mean of the heat-flows measured in Britain[3] is within 20 per cent of that for South Africa[2], even though the British geothermal gradients on which the calculations are based exceed those used in the determinations for South Africa by a factor of three or four. The close agreement of the heat-flows arises because the corresponding conductivities differ also by approximately this same factor.

Should the conductivity of the sediments in which Prof. Pettersson made his measurements of geothermal gradient be appreciably controlled by the conductivity of their water content, as seems not unreasonable, his heat-flows may well be less than the continental value; fresh water at 0° C. and atmospheric pressure has the low conductivity of 0·0013 cal./cm.-sec.-° C. Bridgman[7] has shown that a pressure of 1,000 atmospheres increases the conductivity of water by only some 6 per cent. It is, of course, unlikely that deep-sea sediments will prove to have so low a conductivity as that of water, owing to the presence of the solid material. However, a conductivity as high as about 0·003 cal./cm.-sec.-° C. would be necessary in order for the first two ocean heat-flows to be as great as the continental value. It is therefore by no means certain that the relatively high geothermal gradient of 42° C./km. also implies a high heat-flow under the oceans.

It is to be hoped that Prof. Pettersson will measure the thermal conductivities of some of his cores of sediment, collected from the same regions in which he measured the geothermal gradients, in order to find the local heat-flows. The results would be of great interest.

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[1] Pettersson, H., *Nature*, **164**, 468 (1949).
[2] Bullard, E. C., *Proc. Roy. Soc.*, A, **173**, 474 (1939).
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Ocean Swell: its Decay and Period Increase

Hitherto there has been a difference of opinion concerning the role of eddy viscosity in the behaviour of wind waves and swell. On one hand, Suthons[1] ascribes the lengthening of waves in sea and swell and part of the decay of swell to the effect of eddy viscosity. According to Suthons, waves become longer simply because viscosity tends to increase the depth of water affected by the wave motion, since it transfers kinetic energy downwards. This reasoning does not, however, seem convincing. Obviously, longer waves have greater depths of water affected by the wave motion; but this does not mean that, conversely, the waves would become longer if the depth of water having kinetic energy were increased by effects that have nothing to do with the mechanism of wave motion.

Sverdrup and Munk[2], on the other hand, neglected the effect of viscosity. They ascribe the decay and the period increase of swell entirely to the effect of air resistance, and Sverdrup[3] has presented

theoretical computations in order to show that this effect gives rise to a selective damping, which acts in favour of the longer components of a wave spectrum.

The present communication gives a preliminary account of some computations and considerations which have led us to believe that eddy viscosity is of much more importance for the theory of ocean swell (and also for wind waves) than would appear from the work of Sverdrup and Munk. It is even possible to explain the decay and lengthening of ocean swell by means of selective damping by eddy viscosity alone, and the values of the viscosity coefficient which must then be used in order to obtain a satisfactory agreement with observed rates of decay and of period increase are quite reasonable and even rather small.

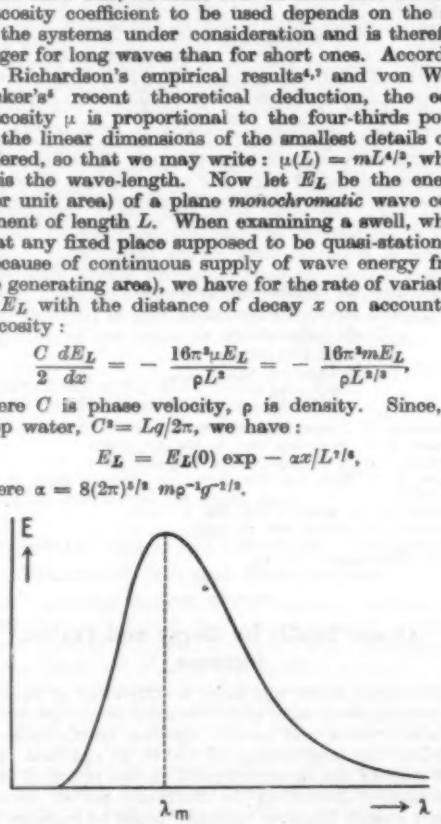
To show this, we must bear in mind that the eddy viscosity coefficient to be used depends on the size of the systems under consideration and is therefore larger for long waves than for short ones. According to Richardson's empirical results[4,7] and von Weizsäcker's[5] recent theoretical deduction, the eddy viscosity μ is proportional to the four-thirds power of the linear dimensions of the smallest details considered, so that we may write: $\mu(L) = mL^{4/3}$, where L is the wave-length. Now let E_L be the energy (per unit area) of a plane *monochromatic* wave component of length L. When examining a swell, which is at any fixed place supposed to be quasi-stationary (because of continuous supply of wave energy from the generating area), we have for the rate of variation of E_L with the distance of decay x on account of viscosity:

$$\frac{C}{2}\frac{dE_L}{dx} = -\frac{16\pi^3\mu E_L}{\rho L^3} = -\frac{16\pi^3 m E_L}{\rho L^{5/3}},$$

where C is phase velocity, ρ is density. Since, in deep water, $C^2 = Lq/2\pi$, we have:

$$E_L = E_L(0)\exp - \alpha x/L^{7/6}, \qquad (1)$$

where $\alpha = 8(2\pi)^{5/2}\, m\rho^{-1}g^{-1/2}$.



We shall use $L^{7/6} = \lambda$ as the independent variable and describe a continuous wave spectrum by means of an energy function $E(\lambda,x)$, such that $E(\lambda,x)d\lambda$ is the wave-energy contained in the part of the spectrum from λ to $\lambda + d\lambda$. Now $E(\lambda,0)$ will, as a function of λ, have a form of the general type shown in the accompanying diagram. Accordingly, we tried, as an analytical representation of the initial spectrum, the following form:

$$E(\lambda,0) = A\lambda^{-a}\exp - b\lambda^{-1},$$

where a and b are as yet unknown positive constants. From (1) it follows that

$$E(\lambda,x) = A\lambda^{-a}\exp - (b + \alpha x)\lambda^{-1}. \qquad (2)$$

The maximum of $E(\lambda,x)$ is found for $\lambda = a^{-1}(b+\alpha x) = \lambda_m$, which we might take to be the dominant or *significant* value of λ. Hence:

$$\lambda_m(x)/\lambda_m(0) = 1 + \alpha x/b. \qquad (3)$$

The total energy is found by integration to be

$$E_{\text{total}} = E_0(1 + \alpha x/b)^{1-a},$$

provided that $a > 1$. If we now take this energy to be proportional to the square of the *significant* wave-height H, we have apparently

$$H(x)/H(0) = (1 + \alpha x/b)^{(1-a)/2}. \qquad (4)$$

It is found that (3) and (4) are in accordance with the semi-empirical relationships found by Sverdrup and Munk[2] if we take $a = 3{\cdot}26$, whereas b, which has the dimension of λ, depends on the initial significant wave-length, that is, the wave-length at the end of the fetch. The value of α which fits most of the observations is $\alpha = 0{\cdot}85 \times 10^{-3}$ (metre)$^{1/6}$, so that m is found to be: $m = 3{\cdot}5 \times 10^{-8}$ kgm.m.$^{-7/3}$ sec.$^{-1}$. This yields for a wave-length of 100 m. a value $\mu = 1{\cdot}6$ kgm. m.$^{-1}$ sec.$^{-1}$ $= 16$ gm. cm.$^{-1}$ sec.$^{-1}$. Since, according to the theory of wind-driven ocean currents, any wind of 2·5 m./sec. would already be sufficient to maintain such a value of the eddy viscosity, our result seems very reasonable.

The assumption, which has been used in the above deduction, of a stationary state is, of course, an over-simplification. Especially if the duration of the wind in the generating area is not so very long (although long enough to reach a quasi-stationary state within the fetch), a stationary state of the swell in remote places will not be reached, because the long waves will already have died out there before the short ones arrive. Thus, in those cases the energy of the swell will, for sufficiently large values of x, be smaller than in the quasi-stationary case, so that even *smaller* values of the eddy viscosity will account for the observed decay.

But how about the air resistance? Sverdrup and Munk[2] ascribed all the energy-loss of swell to air resistance, and their computations based on this assumption seem to support it. There is, however, one more assumption that is essential for those computations, namely, that the value of the so-called 'sheltering coefficient'[6] or 'stream-lining coefficient'[2], which is a measure of the pressure-asymmetry along the wave profile, is the same for swell as for wind waves. This is, however, rather improbable. Indeed, it makes a great difference whether (as in the case of swell in calm air) the air moves only with respect to the wave profile and (practically) not with respect to the water; or, whether it moves also with respect to the water. Since in the first case the resistance due to friction between the air and the water is very much smaller than in the latter case, the pressure-resistance will also be much smaller, especially if we have to do with a long swell of small steepness. It may easily be seen that *without* friction and viscosity there would even be no pressure-resistance at all. Computation of the pressure-resistance of swell is very difficult; but it may be anticipated that it is, in general, of the same order of magnitude as the resistance due to the (small) friction between the air and the water.

Although we are aware of the fact that our presentation of a computation of swell characteristics on the basis of eddy viscosity considerations is, in more than one respect, very much over-simplified, our

conclusion is that eddy viscosity is the principal factor determining the decay and effective period increase of ocean swell.

The lengthening of wind waves forms a different problem; but it seems probable that here also a selective loss of energy due to turbulence acts in favour of the longer waves.

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Spacings of Retained Austenite in Quenched White Cast Iron

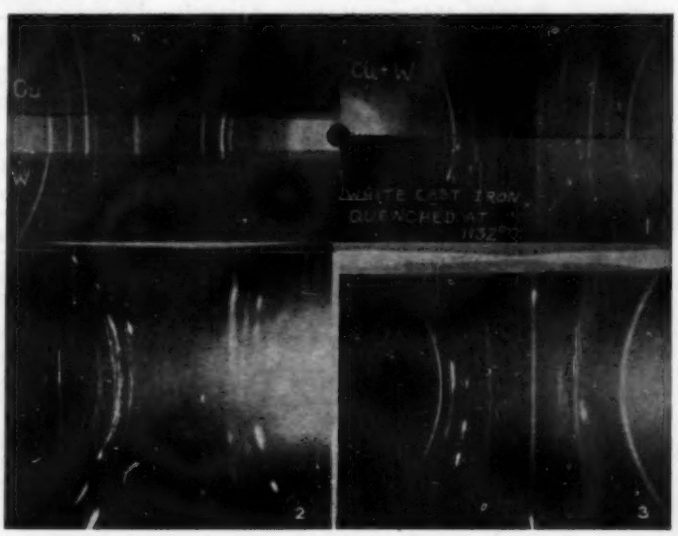
Little data has, as yet, been published concerning the spacings of retained austenite in iron–carbon alloys when the quenched sample contains the quantity of carbon ascribed to the saturation point *E* (1·776 per cent carbon at 1,145° C.) shown in the iron–carbon diagram. The only data as yet found refer to samples of plain carbon steel (1 mm. in diameter) containing 1·74 per cent of carbon and quenched at 1,130° C., for which the authors[1] give $a = 3{\cdot}613$ and $3{\cdot}624$ A. The first of the samples, according to the authors, was decarburized.

The difficulty in preventing loss of carbon when heating thin rods of high-carbon steel is obvious. Consequently, to provide a comparison between the estimated parameters of retained austenite in samples of high-carbon steel with those of samples that have, after heating, retained sufficient quantity of carbon, a white cast iron was chosen in which the total amount of alloying elements (manganese, silicon, phosphorus and sulphur) was less than 1 per cent, that is, similar in quality and quantity to those in mild plain carbon steels. Samples in the form of flat lumps (a few grams in weight) were quenched from a series of $A_{\text{cementite}}$ temperatures. The samples were then polished and examined both microscopically and by X-rays (low-angle glancing reflexion method, cobalt $K\alpha$ radiation). In certain cases the X-ray photogram was repeated and a pure tungsten powder was imposed on the surface for checking the positions of the lines of retained austenite.

For control of the position of the 220 line of austenite, the 211 line of tungsten ($\theta = 43° 52'$) was used. An additional X-ray photogram was taken with pure powders of tungsten and copper, mixed together with tragacanth to give control by the combined substance method[2]. The position of the 220 line of copper ($\theta = 44° 26'$) corresponds to $a = 3{\cdot}61$ A.

The use of this method is demonstrated in Fig. 1. It shows a white cast iron quenched at 1,132° C. in brine. The right-hand bottom part of Fig. 1 shows the sample under examination; the right-hand upper part is for the mixture of copper and tungsten powders, while the left-hand part shows the pure copper and pure tungsten photograms imposed on the copper and tungsten mixture X-ray photogram for the identification of the lines. The positions of the 220 line of copper ($a = 3{\cdot}61$ A.) and that of the retained austenite line ($a = 3{\cdot}62$ A.) are easily compared, the latter equalling in parameter that given by Honda and Nishiyama[1] for plain carbon steel quenched from the same temperature (1,130° C.). The quantity of carbon dissolved in both cases, owing to the temperature of quenching[3], results in the same parameter of retained austenite. Consequently, the assumption that the character of retained austenite in both cases is the same appears to be justified.

One of the samples of white cast iron, when quenched from the semi-liquid state (about 1,180° C.), shows the retained austenite in the form of dots, owing to the large crystals produced during melting (Fig. 2); only two dots represent the 220 line. The X-ray photogram repeated with the tungsten powder deposit shows the 220 line of retained austenite also represented by two dots only (Fig. 3), which overlap with the 211 line of tungsten. The position of the line of retained austenite has moved to the position of the 211 line of tungsten ($\theta = 43° 52'$), giving the parameter of the retained austenite as $a = 3{\cdot}64$ A., that is, more than the value calculated from the formula given by me[3] ($a = 3{\cdot}6281$ for 1·776 per cent carbon). The micro-examination of the sample shows that the grains of retained austenite, owing to incipient fusion, have not only grown into large crystals but also are filled with needles of primary cementite. The dots indicating the 220 line of retained austenite are blurred, revealing the lattice distortion of retained austenite. As there is close linkage between the iron atoms in the interfaces between retained austenite and cementite, this distortion and the increase of parameter must be expected.



This investigation shows: (*a*) the highest spacing given, as yet, for retained austenite in iron–carbon alloys, (*b*) the usefulness of the combined-substance method for the estimation of spacings in the case of samples not suitable for powder-camera photograms. Further, it provides evidence that temperature is the factor deciding the character of retained austenite when sufficient carbon content is secured.

Detailed results connected with the heat treatment of white cast iron and other iron–carbon alloys and describing the nature of retained austenite will be published elsewhere.

I am indebted to Prof. C. W. Dannatt for the provision of facilities in this Department, and for discussion and help in carrying out the experiments.

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Utilization of Acetic and Propionic Acids in Sheep

The level of volatile fatty acid in the peripheral blood of sheep is considerably higher than in non-ruminants, arterial levels reaching 10 mgm. per cent (as acetic acid) or greater, after feeding. The removal of volatile fatty acid from the arterial blood during its passage through the tissues of the head is considerable, and the extent of its removal is closely dependent upon its arterial level[1,2].

Preliminary chromatographic analyses by the method of Elsden[3] showed that acetic acid comprised 100 per cent and 94 per cent of the total volatile fatty acid in samples of arterial and venous blood respectively, and it was suggested that the arterio-venous difference for volatile fatty acid might be accounted for solely by the uptake of acetic acid by the tissues[1]. Recently, McClymont[4] observed arterial volatile fatty acid levels in five cows, after feeding and during fasting, of the same order as those previously reported by me for sheep. He found that acetic acid comprised more than 91 per cent (molar basis) of the volatile fatty acid in their arterial blood, and that small proportions of propionic, butyric and at least two higher acids were also present.

A total of nineteen analyses, by the chromatographic method of Moyle, Baldwin and Scarisbrick[5], have now been carried out on arterial and venous blood from seven sheep on five different rations. Arterial blood was obtained from the exteriorized carotid artery, and venous blood from the external jugular vein. All blood samples were collected four to eight hours after feeding, when fermentation in the rumen was at, or near, its daily maximum. Details of some of the analyses are given in the accompanying table, which includes the extremes of concentration obtained for each acid in arterial blood and, in addition, analyses of venous blood withdrawn at the same time[1,2].

The analyses show that, in sheep fed on rations of widely differing composition, 86–95 per cent (molar basis) of the total volatile fatty acid in arterial blood was acetic acid. Small amounts of propionic, butyric and at least one other acid were present in all samples. There was no evidence that acids, other than acetic, were removed from the blood in significant quantities during its passage through the head.

The efficient uptake of acetic acid by the tissues is compatible with the generally recognized ability of mammalian tissues to oxidize acetate completely. The small amounts of propionic acid in the general circulation indicate that this acid is removed from the portal system by the liver almost as rapidly as it is absorbed from the gastro-intestinal tract. Significant amounts of propionic acid would only appear in the peripheral circulation when the rate of absorption exceeded the maximum rate of its conversion to glucose in the liver. This would explain the comparatively high level of propionic acid found on one occasion in blood samples from sheep 132.

That propionic acid can be converted to glucose in the liver of the sheep has been indicated by Hitchcock and Phillipson[6] and by Jarrett[7], who observed that the administration of this acid to phloridzinized sheep resulted in the formation of equivalent amounts of glucose in the urine. The rapidity of this conversion was first indicated (Reid[1]) by the fact that the intravenous injection of sodium propionate solution relieved severe hypoglycæmic symptoms in an adrenalectomized ewe, following insulin injection, almost as rapidly as an equivalent dose of glucose, the blood-glucose showing an almost immediate rise to the normal level. Similarly, the injection of sodium propionate into two other sheep, with blood-glucose levels of 5 mgm. per cent, following insulin administration, produced an immediate rise in blood-glucose in each case.

A detailed account of this work, which was part of the research programme of the Division of Animal

Volatile Fatty Acids in the Peripheral Blood of Sheep After Feeding

Sheep No.	Ration (parts by weight)	Blood: arterial (A) or venous (V)	Volatile fatty acid concentration ($\times 10^{-4}$ *M*)			% Acetic acid of total (vol. fat. acid)	Total (vol. fat. acid) (as mgm. acetic acid per 100 ml. blood)
			Acetic acid	Propionic acid	Butyric and higher acids		
J. 118	Lucerne chaff 10, Wheaten chaff 30, Wheat 60	A	99	2	11	89	6·7
		V	78	2	6	91	4·7
J. 116	Lucerne chaff 25, Wheaten chaff 75	A	144	1	7	95	9·1
		V	98	1	6	93	6·3
132	Wheaten chaff 50, Wheat 44, Meat meal 5, Ground limestone 1	A	139	19	5	86	9·7
		V	103	20	4	81	7·6
132	do	A	211	8	9	92	13·7
		V	152	6	7	92	9·9
K.559	Lucerne chaff 10, Wheaten chaff 75, Bran 15	A	169	4	7	94	10·8
		V	124	4	7	92	8·1

Health and Production, Australian Commonwealth Scientific and Industrial Research Organisation, is being published elsewhere.

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Growth-Regulating Effect of Certain Organic Compounds

Since the discovery that β-indolylacetic acid and other organic compounds are active in regulating growth and development in the plant, much research has been directed toward the elucidation of the mechanism of regulation. This research has followed several lines, one being the attempt to correlate physiological activity with chemical structure[1–4]. It has been postulated that certain features of molecular structure and configuration are required for activity. Koepfli, Thimann and Went[1] suggest that these features are an unsaturated ring system and a side-chain carrying a carboxyl group at least one carbon atom removed from the ring. After an analysis of many compounds, Veldstra[2] re-orientates these requirements as a basal ring system with high surface activity and a carboxyl group in a very definite spatial position with respect to this ring system. The discussion has been carried further by Muir *et al.*[3], who postulate that, at least for the phenoxyacetic acids, "the position on the benzene ring adjacent to the point of attachment of the side-chain is directly involved in the growth reaction"; that is, if the compound is to have activity, at least one of the ortho positions needs to be free.

There are a number of methods by which activity can be measured. Before full use can be made of such measurements, it is necessary that technique should be standardized. The advantages of the straight-growth method, in which the growth of sections of *Avena* coleoptiles in test solutions is measured, have been concisely stated by Muir and his colleagues. It would seem, on theoretical grounds, that this method would be the most suitable to use for such studies. Further, it has been established by experimental work in this laboratory over the past two years that it can, in fact, be used as a quantitative method of assay. An analysis of experimental procedure for this method, and of variability in the data it provides, will be published shortly[5].

Using the straight-growth method, high physiological activity has been obtained with two compounds, 2,3,6-trichlorbenzaldehyde and 2,3,6-trichlorbenzoic acid. These substances do not fulfil the structural requirements of either Veldstra or Muir. The results are set out in the accompanying table. The figures are the means of tests carried out on four different occasions, using twelve coleoptile sections per solution on each occasion. Growth is expressed in terms of the growth of sections in β-indolylacetic acid at a concentration of 1 mgm./litre. This was used as a control on each occasion and is taken as 100 units.

Concentration (mgm./litre)	2,3,6-Trichlorbenzaldehyde	2,3,6-Trichlorbenzoic acid	2,4-Dichlorphenoxyacetic acid (own data)	2,4-Dichlorphenoxyacetic acid (data of Muir *et al.*)
10·0	Inhibition	100	53	53
1·0	126	78	96	100
0·1	23	40	67	75

It is seen from the table that 2,3,6-trichlorbenzaldehyde is more active than β-indolylacetic acid at 1 mgm./litre; 2,3,6-trichlorbenzoic acid is less active than the aldehyde at the higher concentrations (at 10·0 mgm./litre it has not yet reached the inhibiting range). At 0·1 mgm./litre it is more active. Went[4] reports activity of other substituted benzoic acids as hemi-auxins in the pea test, but not as substances having growth activity. 2,4,6-, 2,4,5- and 3,4,5-trichlorbenzaldehydes have all been tested and have been shown to possess no activity.

It would appear, from these results, that a side-chain with a dipole at an angle to the ring, or a free ortho position in the ring, is not always necessary for activity.

Also included in the table are results for 2,4-dichlorphenoxyacetic acid, from tests carried out in April 1949. These confirm the report by Muir and his colleagues that this compound is effective in promoting cell-elongation. On the assumption that growth is proportional to the logarithm of the concentration, which is true in the straight-growth test, Muir's data have been converted into the same units as my own. Although there are a few points of variation in technique, the results from the two sources agree quite well. This confirms that it is possible with the straight-growth method to compare results between different workers—a necessary prerequisite to any interpretation of the data.

I am indebted to Imperial Chemical Industries, Ltd., Hexagon House, Manchester 9, for their co-operation, especially for supplying the chemicals.

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Some Morphological Features Accompanying the Aerobic Photodegradation of Whole Potato Starch

Peat and Whelan[1] have already described the chemical changes occurring during the aerobic photodegradation of amylose and amylopectin when dispersed in water. More recently, Whelan and Baker[2] have extended these investigations to commercial whole starches in the dry state (note: such starches still contain 15–20 per cent of bound water). During

the aerobic degradation of whole starches, morphological changes were observed which promised to throw some light upon the gross and fine structural organisation of the raw starch granule. When potato starch irradiated in ultra-violet light of 3660 Å. was mounted in a non-aqueous medium such as anisole (refractive index 1·51), microscopic examination showed that the majority of the granules still retained their birefringence. If examined at room temperature, in water, iodine solution or other aqueous reagents, the granules swelled almost immediately and lost their birefringence. These changes were accompanied by the separation of clearly defined surface membranes and by solubilization of the contents of the granule, which diffused slowly into the surrounding medium. Swelling appeared to be due in part to osmosis, since a proportion of the granules burst, leaving the peripheral membrane as a shrunken residue in which a clear rent, through which the solubilized contents had escaped, was always demonstrable. Also, on irrigation with ethanol, the process was reversed and the swollen granules contracted.

These and other features became more prominent when chloral hydrate was used as the swelling agent. On irrigation of chloral hydrate preparations with ethanol, the solubilized material was reprecipitated as an amorphous deposit within and, as a result of diffusion, around the granules. Moreover, where extraction of the solubilized material was complete, as well as a peripheral membrane, an entire series of interlamellar membranes could be observed in the interior of the granule. The membrane system showed no birefringence and gave no reaction with iodine in potassium iodide.

In attempting to assess the significance of these facts, the following points deserve attention. (1) Although separation was accompanied by osmotic swelling of the granule, the separated membranes were themselves unswollen. They bore no morphological resemblance to the swelling artefacts observed by Badenhuizen[3], Alsberg[4] and others, which were produced when potato and other starches were heated with water or swelling agents. (2) Whereas the partially or wholly solubilized contents of the granules gave a strong reaction with Schiff's reagent, no reaction could be observed in the membranes. Moreover, the membrane material was completely insoluble in strong sodium hydroxide solution at 100°. This insolubility, together with the negative Schiff's reaction, would appear to indicate that the aldehyde groups liberated on oxidation had undergone condensation, perhaps with adjacent polysaccharide chains, giving rise to a chemically inert and highly ramified structure. This interpretation would be in agreement with the fact that Haller[5] had previously demonstrated similar structures in potato starch granules treated with chemical oxidizing agents. (3) Since 99 per cent of whole potato starch can be accounted for as glucose residues, it seemed unlikely, though this possibility could not be definitely excluded, that the interlamellar material was not a carbohydrate. In that case the formation of resistant membranes by the interlamellar polysaccharide might be attributed to differences in kind or degree of supermolecular organisation rather than of chemical composition. The existence of such differences is, moreover, independently indicated by Frey-Wyssling's[6] demonstration of periodic variations in refractive index in the lamellæ of potato starch granules.

Furthermore, that the membrane system disclosed by photodegradation reflected a real difference in the intrinsic structural organisation of the intact granule was substantiated by the following additional facts. (4) When granules damaged by grinding in a ball mill for 48 hours at 50 r.p.m. were irradiated in ultra-violet light, osmotic swelling did not occur on contact with water and only damaged membrane residues were recovered. (5) Similar membrane structures could be demonstrated when starches baked at 200° C. were mounted in water or aqueous reagents, provided that swelling was retarded by dilution of the water or reagent with ethanol. Thus, the regional differences in rate of dextrinization disclosed by baking were essentially similar to the regional differences in rate of oxidation disclosed by photodegradation. (6) When maize starch was irradiated, no membrane residues were found; nor did osmotic swelling of the granules in aqueous media occur. The observed structural features of photodegradation, therefore, were in some way dependent upon the botanical origin of the starch. It may be noted, in conclusion, that such interspecific differences may be of other than purely academic interest, since Baker, Nasr and Morrice[7] have shown that the supermolecular organisation of starch granules exerts a determinant influence on the site, agents and nutritional outcome of starch breakdown in the gastro-intestinal tract.

We wish to thank Mr. Godden, head of the Biochemistry Department at the Rowett Research Institute, for recalling our attention to the significance of the membrane problem for nutrition.

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Mepacrine Hydrochloride in the Treatment of Avian Coccidiosis

IN a previous communication[1], two experiments were described in which mepacrine hydrochloride appeared to have a beneficial effect in the treatment of acute cæcal coccidiosis of chicks. In two treated groups, each comprising forty chicks, the death-rate was seven compared with twenty-six and twenty-three respectively in control pens of the same number, and it was suggested that this drug might prove a most useful agent in combating avian coccidiosis.

Further experiments on the lines indicated in the note were carried out, but the earlier promise of the drug was not maintained, results being frankly disappointing even when the dose was increased to 2 gm. per gallon of drinking water. In the later experiments, however, treatment did not begin until 72 hr. after the oral administration of oocysts, and this may

partially explain the discrepancy in the results. In every case an equal number of infected chicks received sulphamezathine sodium (2 ounces per gallon of drinking water), and the death-rate in these groups was invariably insignificant.

Although it has no practical bearing, it may be of interest to note that, in two groups of chicks given mepacrine hydrochloride (2 gm. per gallon) for three days and seven days respectively prior to dosing with oocysts and continued for five days afterwards, the death-rate was 64 per cent and 57 per cent respectively compared with 92 per cent in untreated infected chicks, suggesting that the drug does have some coccidiostatic properties. In a control pen dosed with oocysts on the same day and given sulphamezathine sodium in the usual strength 72 hr. later and continued for five days, the death-rate was only 4 per cent.

It is apparent, therefore, that mepacrine hydrochloride compares very unfavourably with sulphamezathine sodium, and its use in the treatment of acute cæcal coccidiosis of chicks cannot be recommended.

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Experiments with 'Gammexane' in the Control of Lice on Poultry and their Bearing on the Problem of Vitamin D Intake

Recently, I conducted a series of experiments to determine the tainting effect of 'Gammexane' (benzene hexachloride) when used for the control of body lice on poultry. A commercial louse powder containing 5 per cent benzene hexachloride (15 per cent gamma isomer) was used. Dusted on the birds, this gave rapid and prolonged control of louse infestation, and when eggs from these birds were submitted to a panel of tasters they could detect no difference from eggs laid by control hens. Similarly, no taint could be detected in the meat when dusted birds were cooked and eaten. In the most severe test, birds were excessively dusted four times at weekly intervals and killed one week after the final dusting.

As a simpler method of louse control, the powder was sprinkled on the perches before the birds went to roost. The effect was not so lasting, but was easily repeated when necessary. The fumes of benzene hexachloride caused no tainting.

The third method tried was to sprinkle the powder heavily on the floor litter, the parasites being killed during dust-bathing. When grain is fed in this litter, a certain amount of benzene hexachloride is ingested; and a high proportion of taints were found in the eggs and the flesh, the proportion of tainted eggs being highest about eight weeks after the application. There were also indications that hatching and fertility were impaired.

I consider that if used with care, so that no food is contaminated, 'Gammexane' is a more certain and a cheaper way of controlling body lice than the standard New Zealand method of using nicotine sulphate.

Quite apart from these conclusions, the results are extremely interesting in view of G. H. Bourne's communication[1] on the antirachitic value of sunbathing in animals. Bourne directed attention to the work of Hou[2,3], who considered that birds obtained vitamin D through the irradiation of the preen oil spread over the feathers. Hou[4] showed that the skin and feathers are antirachitic, and suggested that, while preening, the bird took some of the irradiated oil into its mouth. In a later paper[5], however, he makes it clear that the irradiated oil is not the only source of vitamin D, or even the major source, as Bourne seems to suggest; since he found irradiation of the legs and feet to be the most rapid way of curing rickets.

In view of the marked taint caused in eggs and flesh by the intake of a small amount of benzene hexachloride when feeding from contaminated litter, and the absence of taint when birds were dusted with a benzene hexachloride powder, it appears that virtually none of this substance was ingested by the latter group while preening. It does not seem, therefore, that poultry ingest an appreciable amount of preen oil since, in the dusted birds, this would be liberally mixed with 'Gammexane'. I would therefore suggest that the vitamin D formed in the oil by irradiation is not taken into the mouth, but is absorbed through the skin or down the feather shaft. Hou[1] has demonstrated the presence of oil droplets within the feather.

Since Hou and Tso[6] showed that human sebum is antirachitic, a similar method of vitamin D absorption may occur in mammals, where the sebaceous gland ducts form a known path[7] for the entry of fat-soluble substances.

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Effects of Penicillin and Streptomycin on Vaccine Lymph (Calf Lymph)

Heavy bacterial contamination of vaccine lymph (calf lymph), sometimes as high as 500 millions per ml., is inevitable during manufacture. The contaminants, in the tropics, though consisting mostly of staphylococci, may include a few *B. subtilis*, *B. coli*, *Streptococcus*, fungus, etc. None of the methods now used for their elimination is completely satisfactory. I have made a detailed study of the effects of penicillin and streptomycin on vaccine lymph under different conditions.

Penicillin is ineffective[1,2], contrary to the views held by certain workers[3,4,5], in reducing the bacterial contaminants of glycerinated vaccine lymph. This ineffectiveness is masked until and unless the sterility tests are made after complete removal of the residual

penicillin from the penicillin-treated lymphs; for the bacteria in glycerine vaccine lymph are in a 'resting phase' in a non-nutrient medium; and penicillin is not bactericidal but only bacteriostatic under such conditions, as shown by Chain and Duthie[6].

Streptomycin, on the other hand, in a concentration of 5 mgm. per ml., reduces the bacterial flora of the glycerinated lymph, excepting the spore-bearers. In one experiment, the staphylococcal population of about 252 millions per ml. of vaccine lymph was reduced to a mere 240 per ml. within 24 hours contact with streptomycin in cold storage and to 40 per ml. after a further week. This finding is in conformity with the results of Strauss[7] and Garrod[8], who found that streptomycin is bactericidal both in nutrient and non-nutrient fluids, but in rather high concentrations in the latter. Acting synergistically with penicillin, as little as 500 μgm. of streptomycin with 500 units of penicillin per ml. of lymph is equally effective.

Streptomycin, both singly and in combination with penicillin, added to vaccine pulp immediately after its collection from the calf (but without addition of glycerol) and incubated at 37° C. for 24 hours, evoking a growth-phase of organisms, effectively reduces the bacterial flora of the vaccine lymph. *B. subtilis* spores do not remain unaffected. Under the same conditions, penicillin, by itself, in a concentration of 500 units per ml., acts on susceptible groups of bacterial contaminants but allows an abundant growth of *B. coli* organisms commonly present in the vaccine lymph.

Mere external application of 1,000 units of penicillin and 5,000 gm. of streptomycin per ml. in sterile 50 per cent glycerine over the vaccinated area of the calf twice a day for five days reduces the bacterial contamination substantially. In this series of experiments, the bacterial content was only 200 per ml. of vaccine lymph from the treated animal, compared to 400 millions per ml. for the untreated control animal.

Parenteral administration of 40,000 μgm./kgm. weight streptomycin in combination with 8,000 units of penicillin/kgm. weight to a vaccinated animal in four divided doses daily, along with external application of streptomycin over the vaccinated area twice daily for five days, reduces the bacterial contamination[9] much nearer to sterility than other methods. Repeated sterility tests revealed entire absence of bacteria; a colony of fungus was occasionally seen.

As against other methods, streptomycin and penicillin do not affect the potency of vaccine lymph under these conditions, and thus allow the use of highly diluted vaccines.

A practical application of these findings is that it permits the preparation of a purer calf lymph at a substantially lower cost than at present.

V. N. KRISHNAMURTHY
Government Vaccine Institute,
Bangalore.
Nov. 14.

[1] Krishnamurthy, V. N., *Curr. Sci.*, **10**, 373 (1949).
[2] Krishnamurthy, V. N. (in the press).
[3] Diaz Romero, *Arch. Soc. Biol. Montevideo*, **12**, 152 (1945); *Abs. J. Amer. Med. Assoc.*, **131**, 1100 (1946).
[4] Morin, J., and Turcotte, H., *Canad. J. Res., E*, **24**, 149 (1946).
[5] Patel, T. B., *Ind. Med. Gaz.*, **10**, 452 (1948).
[6] Chain and Duthie, E. S., *Lancet*, i, 652 (1945).
[7] Strauss, E., *Proc. Soc. Exp. Biol. N.Y.*, **64**, 97 (1947).
[8] Garrod, L. P., *Brit. Med. J.*, **1**, 382 (1948).
[9] Pulaski, E. J., *et al.*, *Ann. N.Y. Acad. Sci.*, **48**, 183 (1946).

Transport of Insects on the Exterior of Aircraft

THE carriage of insect eggs on the external surfaces of aircraft, as described by Senior, White and Kirkpatrick[1], is obviously of great potential importance to those concerned with quarantine against insect pests of agriculture and forestry. It is important that similar observations should be recorded so that it can be judged whether this means of distribution is rare and accidental or significantly constant in occurrence.

My own observations also relate to lepidopterous eggs, and it seems likely that insects of this order may furnish most of the examples of this means of distribution.

En route from Raratonga to Samoa on August 11, 1949, the N.Z. *N.A.C.* plane *Piere* stopped at Aitutaki, where Commander Malcolm directed my attention to what appeared to be insect eggs deposited on the fibrous tips of the static release cords on the tail plane. The eggs were unfortunately not kept for study. The plane spent the night of August 11 in the open on Faleolo airport, Upolu Isles, Western Samoa, and departed next day for Tonga. During the flight, Commander Malcolm came back to me with the drift recorder which projects under the plane. Two masses of eggs each about $\frac{1}{8}$ in. long by $\frac{1}{4}$ in. wide had been deposited on the drift recorder, one on the mirror and one on the housing. If the drift recorder was in use the previous day, as is almost certain, any eggs then present on the mirror would have been noticed. It is therefore highly probable that the eggs were laid while the plane was at Faleolo. The eggs, on subsequent examination, were found to be sub-spherical and with a sculptured chorion and covered or mixed with fine linear scales or hairs. They were definitely lepidopterous, but I am unable to suggest the family to which they belong. First instar lepidopterous larvæ hatched from some of these eggs in the laboratory.

L. J. DUMBLETON
Entomological Research Station,
Nelson, N.Z.

[1] *Nature*, **164**, 60 (1949).

Projection of the Olfactory Epithelium on to the Olfactory Bulb: a Correction

IN a study of the peripheral pattern of olfactory innervation[1], observations were made on the rate of retrograde degeneration of olfactory receptors following lesions of the olfactory bulb. It was incidentally noted that, at least over the cartilaginous part of the septum examined, partial ablation of the bulb appeared to lead to a general thinning out of the receptors rather than to a localized area of complete atrophy. It was therefore inferred that, if the septal mucosa can be assumed to be representative of the olfactory mucosa as a whole, olfactory nerve fibres from each local area are distributed to all parts of the bulb. Afterwards, Adrian adduced good evidence, based on electro-physiological methods, that there is at least some degree of localization in the bulb, and indicated that this may have an important reference to problems of olfactory discrimination[2]. It was therefore deemed necessary to re-investigate the matter anatomically on a much more extended scale.

In a series of ten rabbits, varying proportions of the olfactory bulb were removed and, several weeks

later, the animals were killed and complete serial sections prepared through the whole of the olfactory cavity in order to determine the regional distribution of retrograde degeneration in the olfactory epithelium. A preliminary study of these sections now makes it clear that there is certainly some degree of regional projection of the olfactory epithelium on to the bulb in the rabbit, and that the inference made on the basis of the earlier material of Clark and Warwick was premature.

W. E. Le Gros Clark

Department of Human Anatomy,
University Museum,
Oxford.

[1] Clark, W. E. Le Gros, and Warwick, R. T. T., *J. Neur. Neurosurg. and Psych.*, **9**, 101 (1948).
[2] Adrian, E. D., "Sensory Integration" (University Press of Liverpool, 1949).

Stability of some Metal Complexes of Histidine

In the course of measuring the stability constants of internal complexes formed by the combination of a number of different bivalent metal ions with a series of α-amino-acids, including histidine, it was noticed that the last-named substance formed complexes that were much more stable than those of any other amino-acid studied.

The overall stability constant (K) for some of the different metal α-amino-acid complexes in water at 25° C. was determined by measuring the individual step reaction equilibrium constants:

$$Me^{++} + A^- \underset{}{\overset{k_1}{\rightleftharpoons}} MeA^+$$
$$MeA^+ + A^- \underset{}{\overset{k_2}{\rightleftharpoons}} MeA_2,$$

where Me^{++} is the bivalent metal ion and A^- is the ligand (α-amino-acid). The overall stability constant of the complex MeA_2 is given by the relation $K = k_1.k_2$. Some values obtained for log K are shown in the accompanying table.

	Histidine	Glycine	α-Alanine	Valine	Leucine
Cu	18·33	15·42	14·83	14·45	14·34
Co	13·86	8·94	8·78	8·24	8·26
Zn	12·88	9·72	9·50	9·10	8·93
Mn	7·74	6·63	6·05	5·56	5·45

In the table, the order of the metals as regards the stability of their complexes is similar to that already noted with other ligands[1-4]. The interchange of the positions of the metals zinc and cobalt with some ligands has been noted previously[5].

If the complexes of any one metal are considered, it will be seen that the stability constants of the complexes formed with the α-amino-acids glycine, alanine, valine and leucine are of much the same order; the stability of the histidine complex, however, is much greater than any of these. This suggests that histidine is attached to a metal atom by groups different from those involved in the co-ordination of the other amino-acids. The latter are attached through carboxyl and amino-groups[6], the former probably through amino- and imino-groups[7].

In a study of the inhibiting effect of cobalt on various aerobic and anaerobic organisms and tumours, Burk and his collaborators[8] observed that, of a number of amino-acids tested, histidine and two of its derivatives were able to nullify the inhibiting effect of the metal. The data reported in the table provide, to some extent, a quantitative basis for the explanation offered by these authors[8] for the mechanism of the nullifying action of histidine. The two series of amino-acids studied were not identical, and further information on the stability constants of metal-amino-acid and other complexes is required before inhibiting actions like the above can be understood in detail. It is evident, however, that similar compounds which are capable of forming complexes of the same order of stability as those of histidine should be equally effective in overcoming the inhibiting effect of metal ions.

A fuller account of this work will shortly be published in the *Australian Journal of Scientific Research*.

L. E. Maley
D. P. Mellor

Department of Chemistry,
University of Sydney.
Oct. 18.

[1] Mellor, D. P., and Maley, L. E., *Nature*, **161**, 436 (1948).
[2] Irving, H., and Williams, R. J., *Nature*, **162**, 746 (1948).
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[4] Ackermann, H., Prue, J. E., and Schwarzenbach, G., *Nature*, **163**, 723 (1949).
[5] Maley, L. E., and Mellor, D. P., *Aust. J. Sci. Res.*, A, **2**, 92 (1949).
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Additive Effects of Substituents

The present practice of analysing data relating to reaction-rates in solution in terms of the parameters of the modified Arrhenius equation,

$$k = PZ \exp - E/RT,$$

has led to a more complete understanding of the way in which polar substituents affect chemical reactivity by focusing attention on the fact that the differences in rate may arise through changes in the energy of activation or in the entropy of activation (non-exponential term) or in both. Among the several reactions investigated, a number have been found in which the differences in rate can be accounted for almost entirely by changes in the energy of activation, variations in PZ in comparison being almost negligible.

Three such reactions are (I) the nuclear chlorination of phenolic ethers[1], (II) the benzoylation of anilines[2], and (III) the alkaline hydrolysis of ethyl benzoates[3]. Hitherto, in both the benzoylation of anilines and the hydrolysis of ethyl benzoates, investigations have been confined to the study of the influence of a single substituent in the benzene nucleus. Only in the first reaction, the chlorination of phenolic ethers, were the influences of two or more substituents determined. The rates of reaction of some two hundred ethers have been examined, and the important conclusion was reached that in ethers of the types p-$RO.C_6H_4.X$ and $RO.C_6H_3.X_2$ the effects of the groups R and X are additive.

The recent publication[4] of the results of a study of the rates of benzoylation of twenty-one disubstituted anilines in which it was found that "the resultant effect on the activation energy of two substituents in the same benzene nucleus is very closely the sum of their individual effects" is important, since it provides new and valuable evidence for the additive effect of substituents.

Evidence for a similar additivity is now available for the third of the three reactions, the alkaline hydrolysis of ethyl benzoates. Some twenty-five disubstituted esters have been examined, and the agreement between the values of the energy of activation obtained from the values of log k and those predicted on the assumption of a strictly additive relationship shows the same degree of correspondence as that obtained in the benzoylation of disubstituted anilines.

A full account of this investigation will be published elsewhere.

BRYNMOR JONES
J. ROBINSON

University College,
Hull.
Oct. 31.

[1] Jones, Brynmor, *J. Chem. Soc.*, 418, 676 (1942); cf. also *J. Chem. Soc.*, 1006 (1928), 183i *et seq.* (1935).
[2] Williams and Hinshelwood, *J. Chem. Soc.*, 1079 (1934).
[3] Ingold and Nathan, *J. Chem. Soc.*, 222 (1936). Evans, Gordon and Watson, *J. Chem. Soc.*, 1430 (1937).
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Geological Age of Meteorites

IN a recently published survey of radiochemical and astronomical results on the age of the universe, the late Prof. R. C. Tolman[1] referred to the "surprisingly wide range of values" found by us[2] for the dates of solidification of meteoritic material. To other competent reviewers this range has appeared equally "perplexing"[3]; but even under the assumption that all meteorites are fragments of one planet, which, after its disintegration, have never been modified by a close approach to the sun, there seems to be no valid reason for the expectation that the ages of all of them should be of the same order.

While it is generally known that the rocks of the earth's surface belong to very different geological periods, there always was, and still is, a tendency among scientific men to picture the formation of the three main layers (core, mantle and crust) of any terrestrial planet as the result of a simple physico-chemical separation, completed in one process at a fairly early stage of its development, under conditions of thermodynamic equilibrium[4]; but the study of many meteorites shows clearly that they have undergone repeated disruption and conglomeration and alternate heating and cooling. The mechanism and duration of these processes are still unknown, but they must have delayed the final solidification of some meteorites.

We are at present engaged in an extension of our meteorite studies. The new results may alter somewhat the earlier figures; but it seems improbable that they will indicate anything like a uniform age of all meteorites. There are no fossils in meteorites to guide us; but we believe that the wide range of ages found by the helium method for meteorites is the first indication of different geological periods in the history of their parent planet.

F. A. PANETH
Londonderry Laboratory for Radiochemistry,
University of Durham.
Jan. 9.

[1] Tolman, R. C., *Rev. Mod. Phys.*, 21, 374 (1949).
[2] Arrol, W. J., Jacobi, R. B., and Paneth, F. A., *Nature*, 149, 235 (1942).
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An Alternative to Latin Diagnoses

THE International Rules of Botanical Nomenclature call for the diagnoses of new species and other groupings of plants to be given in Latin. In so far as the algæ are concerned this is to be regretted. From Latin diagnoses it is often impossible to obtain a clear description of the alga concerned or to distinguish it from one or more closely allied species. This is in part due to the impossibility of rendering, in Latin, the finer shades of meaning that can, for example, be expressed in French, German or English.

In Great Britain, at least, there are few men of science with a deep knowledge of Latin. Commonly, assistance has to be obtained in making Latin diagnoses or, what is worse, someone other than the author translates them. The translator may well neither be an algologist nor even a botanist. Even those proficient in Latin say it is not always possible to make an accurate rendering of all the terms used, nor can their readiness to assist be imposed upon too frequently.

It is said that, if diagnoses in other scientifically international languages are permitted, some biologists will take objection to and fail to use the languages chosen. This is, however, scarcely different from the present position when many hundreds of species of freshwater algæ are not diagnosed in Latin. Officially none is valid; but is anyone going to suggest that re-diagnosis in Latin will be other than a waste of time and paper? We even reach the absurd position where authors give shortened diagnoses in Latin "to comply with the International Rules". If my suggestion were adopted, every algologist would be able to render one of the two diagnoses called for in his own language. Zoologists have long given up Latin diagnoses and have not found it necessary to return to them. Since many algæ are included in both the animal and plant kingdom it seems particularly appropriate that the rule should be altered for this group. It appears that taxonomists of the higher groups of plants are firmly wedded to Latin diagnoses; but it may be hoped that a special ruling can be made for algologists at the forthcoming International Congress in Sweden, and a proposal has been submitted with this end in view.

The suggestion is that the second language in which the diagnoses is given should be French, German or English. Every taxonomist must be able to read these three languages, in which, moreover, the finer shades of meaning can be adequately expressed. Above all, it should be compulsory to give an illustration and the pertinent dimensions.

The suggested rule is therefore as follows. The diagnoses of all algal varieties, species, genera or higher classificatory groupings shall be given in two languages, one of which shall be French, German or English. The diagnoses shall be accompanied by an adequate illustration or illustrations and by the pertinent dimensions.

I should be glad to have the opinions of botanists on this matter and any suggestions for a more suitable wording of the rule.

J. W. G. LUND

Freshwater Biological Association,
Wray Castle,
Ambleside,
Westmorland.
Feb. 13.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 20

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Dr. Colin J. Smithells: "The Manufacture, Properties and Applications of Aluminium and its Alloys" (Cantor Lectures). (Further Lectures on March 27 and April 3.)

INSTITUTION OF ELECTRICAL ENGINEERS, READING DISTRICT (at the Great Western Hotel, Reading), at 7 p.m.—Dr. W. G. Radley: "Trends of Development in Line Communication".

INSTITUTION OF OFFICE MANAGERS, SHEFFIELD BRANCH (joint meeting with the NATIONAL INSTITUTE OF INDUSTRIAL PSYCHOLOGY, at the Royal Victoria Station Hotel, Sheffield), at 7 p.m.—Mr. J. M. Fraser: "Nerve Centres of Industry".

INSTITUTION OF THE RUBBER INDUSTRY, LIVERPOOL SECTION (at Common Hall, Hackins Hey, Liverpool), at 7 p.m.—Mr. F. Amon: "Carbon Black Manufacture in England".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr. H. St. J. B. Philby: "The Transformation of Arabia".

Tuesday, March 21

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Sir Richard Winstedt: "Protohistoric Elements in Malaysian Culture".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mrs. Barbara Bosanquet: "The Quality of the Rural Population".*

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. H. W. Ashton and Mr. G. T. Meiklejohn: "Cost Estimating in Process Development".

INSTITUTION OF ELECTRICAL ENGINEERS, CAMBRIDGE RADIO GROUP (at the Technical College, Cambridge), at 6 p.m.—Mr. W. Allen: "The Acoustics of Studios and Auditoria".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. A. D. Young: "Boundary Layer at High Speeds".

Wednesday, March 22

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Prof. John Read, F.R.S.: "Chemistry as an Instrument of Culture" (Pope Memorial Lecture).

PHYSICAL SOCIETY, COLOUR GROUP (at the Royal Photographic Society, 16 Prince's Gate, London, S.W.7), at 3.15 p.m.—Tenth Annual General Meeting; at 3.30 p.m.—Mr. H. O. Dickinson: "Some Aspects of the Dye Sensitizing of Photographic Emulsions".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, CHEMICAL SECTION (at the Portico Library, Mosley Street, Manchester), at 5.45 p.m.—Dr. P. V. Youle: "P. B. Shelley's Chemistry Box".

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL OF THE FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—"The Nation's Manufactured Foods, 4, Jams and some other Spreads as Food".

CHEMICAL SOCIETY, MANCHESTER SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Dr. H. W. Thompson, F.R.S.: "Some Recent Applications of Infra-Red Spectroscopy".

ROYAL STATISTICAL SOCIETY, BIRMINGHAM GROUP OF THE INDUSTRIAL APPLICATIONS SECTION (in the Chamber of Commerce, 95 New Street, Birmingham), at 6.30 p.m.—Dr. D. G. Beech: "Graphs and Correlation".

INSTITUTION OF ELECTRICAL ENGINEERS, MERSEY AND NORTH WALES CENTRE (at the Philharmonic Hall, Hope Street, Liverpool), at 6.45 p.m.—Dr. R. A. Smith: "Radar" (Faraday Lecture). (To be repeated on Tuesday, April 18, at the Royal Technical College, Glasgow, at 7 p.m., on Thursday, April 20, at the Literary and Philosophical Society, Westgate Road, Newcastle-upon-Tyne, at 7 p.m., and on Tuesday, May 2, at the Wellington Hall, Belfast, at 7.30 p.m.)

BRITISH INSTITUTION OF RADIO ENGINEERS, WEST MIDLANDS SECTION (at the Wolverhampton and Staffordshire Technical College, Wulfruna Street, Wolverhampton), at 7 p.m.—Mr. A. A. Dewey: "Radio Interference with Broadcast Reception".

ROYAL INSTITUTE OF CHEMISTRY, DUBLIN AND DISTRICT SECTION (in the Department of Chemistry, University College, Dublin), at 7.45 p.m.—Dr. A. E. Werner: "The Scientific Examination of Pictures".

Thursday, March 23

CHEMICAL SOCIETY, LIVERPOOL SECTION (in the Chemistry Lecture Theatre, The University, Liverpool), at 4.30 p.m.—Prof. M. G. Evans, F.R.S.: "Photo-excited Electron-transfer Reactions".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. M. J. Kelly: "The Bell Telephone Laboratories—an Example of an Institute of Organized Creative Technology".

LINNEAN SOCIETY OF LONDON (joint meeting with the SYSTEMATICS ASSOCIATION, at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "Biometrics and Systematics" (to be opened by Dr. R. Melville, Prof. Duncan Leitch and Dr. C. B. Williams).

LONDON MATHEMATICAL SOCIETY (at University College, Gower Street, London, W.C.1), at 5 p.m.—Prof. B. Segre: "Bertini Forms and Hessian Matrices".

MINERALOGICAL SOCIETY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

INSTITUTION OF ELECTRICAL ENGINEERS, NORTH MIDLAND CENTRE (at the Lighting Service Bureau, 24 Aire Street, Leeds), at 6 p.m.—Discussion on "The Teaching and Functions of Mathematics in Electrical Engineering Courses". (Education Discussion Circle Meeting.)

PLASTICS INSTITUTE, LONDON AND DISTRICT BRANCH (at the Waldorf Hotel, Aldwych, London, W.C.2), at 6.30 p.m.—Mr. J. H. Collins: "Protein Plastics".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at the South-East Essex Technical College, Longbridge Road, Dagenham), at 7 p.m.—Dr. R. Slack: "The Chemistry of some Actinomycetic and Bacterial Antibiotics".

Thursday, March 23—Friday, March 24

NATIONAL ASSOCIATION FOR MENTAL HEALTH (at Seymour Hall, Seymour Place, London, W.1).—Conference on "Mental Health and the Family".

Friday, March 24

ASSOCIATION OF APPLIED BIOLOGISTS (in the Mining Lecture Theatre, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7), at 11 a.m.—Scientific Papers.

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, University College, Gower Street, London, W.C.1), at 11.30 a.m.—Annual General Meeting.

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion on "The Formation and Destruction of Beaches".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Miss Anne G. Shaw: "The Full Application of Motion Study".

MANCHESTER STATISTICAL SOCIETY, INDUSTRIAL GROUP (at the Albert Hall, Peter Street, Manchester), at 6.45 p.m.—Mr. A. Howarth: "Measurement of Production".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "Computing Machines and Brains" (to be opened by Mr. T. Gold, Mr. D. A. Sholl and Mr. A. M. Turing).

Sunday, March 26

INTERNATIONAL HAEMOPHILIA SOCIETY (at the Society for Visiting Scientists, 5 Old Burlington Street, London, W.1), at 2.30 p.m.—Annual General Meeting.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER (graduate) to teach Physics to Final B.Sc. standard, and a LECTURER (graduate) to teach Mathematics to Final B.Sc. standard—The Principal, Technical College, Essex Road, Dartford (March 25).

SENIOR LECTURER IN BOTANY at the Brighton Technical College—The Education Officer, Education Office, 54 Old Steine, Brighton (March 25).

LECTURER IN PRODUCTION ENGINEERING—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (March 25).

ORGANIC CHEMIST IN THE TECHNICAL CHEMISTRY DEPARTMENT—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (March 27).

SCIENTIST, Grade III (with a good honours degree in chemistry, preferably with some experience of, or special interest in, investigational work on chemical analysis)—The National Coal Board, Establishments Branch (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/195 (March 27).

CHIEF ENGINEER in the Public Health Engineering Department, Government of Bihar—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2, quoting No. 476.A (March 31).

ENTOMOLOGIST in the Department of Agriculture and Lands, Southern Rhodesia—The High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (March 31).

CHAIR IN THE HUMANITIES, and the CHAIR OF METALLURGY, at the New South Wales University of Technology—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (April 1).

HOOVER POSTGRADUATE STUDENTSHIP IN PHYSICS, CHEMISTRY, ENGINEERING, or an allied subject—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 1).

EXPERIMENTAL OFFICERS at Aircraft Experimental Establishments in Southern England: (*a*) PHYSICIST or ELECTRICAL ENGINEER to plan flight tests and supervise installations of new aircraft radio and radar equipment, (*b*) PHYSICIST for flight testing of new aircraft navigation equipment, (*c*) ENGINEER (Mech. or Aero) to take charge of section studying problems of glider towing and aircraft snatch, (*d*) PHYSICIST or ENGINEER with general experience transport aircraft for work on loading, stressing, etc., of aircraft, (*e*) ENGINEER preferably with experience on flight test work for aircraft performance testing, (*f*) ENGINEER for work on airframe structures and general installation and engineering appraisal of aircraft, (*g*) PHYSICISTS or ENGINEERS (Mech. or Aero) with interest in aircraft and in flying for performance testing and flight test work in prototype aircraft and equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.32/50 for posts *a*, *b*, *d* and *g*, or C.87/50 for posts *c*, *e* and *f* (April 1).

EXPERIMENTAL OFFICERS (3, temporary) in the Mechanical Engineering Research Organisation (Department of Scientific and Technical Research) for (*a*) the application of electronic techniques to the measurement of transient forces and small movements (Ref. D.48/50A), (*b*) basic research on the machinability of metals (Ref. C.89/50A), and (*c*) the design and development of equipment and instruments for investigating the performance of and the flow conditions in models of pumping machinery, etc. (Ref. C.90/50A)—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (April 1).

TECHNICAL AUTHORS at Admiralty headquarters and in various Naval Establishments, to prepare official technical publications and handbooks on armament, mechanical and electrical apparatus, radio equipment and underwater weapons, including Asdic, used in H.M. ships—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.49/50A (April 1).

DEVELOPMENT OFFICER (Industrial Machinery), Government of India, to advise and assist in the improvement of industrial machinery manufactured in India—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2, quoting No. 479.A (April 3).

BACTERIOLOGIST (medical) in the Government Medical Laboratories, Western Australian State Public Service—The Official Secretary, Western Australian Government Office, Savoy House, 115–116 Strand, London, W.C.2 (April 6).

PHYSICAL CHEMISTS (Senior Scientific Officer grade) in the Ministry of Supply in London, for duties involving liaison with Service and Overseas Departments and development work concerned with application of plastics and rubbers to Service use—The Ministry of Supply and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.158/50A (April 8).

SCIENTIST, Grade III (with an honours degree in science, preferably in chemistry or physics, or an equivalent qualification) (Ref. TT/197), and a SCIENTIFIC TECHNOLOGIST, Grade II (with a H.S.C., preferably with physics and chemistry, or an equivalent qualification) (Ref. TT/198), in the Scientific Department of London headquarters—The National Coal Board, Establishments Branch (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting the appropriate Ref. No. (April 10).

PROFESSOR OF APPLIED PHYSIOLOGY—The Secretary, Royal College of Surgeons, Lincoln's Inn Fields, London, W.C.2 (April 12).

RESEARCH WORKERS (should be qualified as chemical or electrical engineers, or have graduated with honours in physics or chemistry, or hold equivalent qualifications) to carry out investigations in carbonization, briquetting, coal preparation, electrical and mechanical engineering problems connected with the Coal Industry—The National Coal Board, Establishments Branch (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/200 (April 12).

STAFF TUTORSHIP IN PSYCHOLOGY—The Director, Department of Extra-Mural Studies, Senate House, London, W.C.1 (April 12).

LECTURER IN THE DEPARTMENT OF PSYCHOLOGY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (April 14).

LECTURER or ASSISTANT LECTURER IN THE FLUID MOTION LABORATORY—The Registrar, The University, Manchester 13 (April 14).

PHYSICISTS for (*a*) electrical and optical recording in connexion with underwater ballistic investigation, (*b*) with good knowledge mathematics for general experimental research, (*c*) with general experience and interests, including knowledge electronics, (*d*) with knowledge electronics and radar or strain gauge work, (*e*) for radiological research (industrial X-ray experience desirable), and PHYSICISTS or ELECTRICAL ENGINEERS with (*a*) experience in design use and servicing of electronic instruments, (*b*) experience in use of electronic techniques (experimental ability essential), in Ministry of Supply Research and Development Establishment near London—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.29/50A (April 14).

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, King's College, Strand, London, W.C.2 (April 15).

LECTURER IN INDUSTRIAL PSYCHOLOGY—The Registrar, The University, Leeds 2 (April 15).

RAMSAY MEMORIAL FELLOWSHIP FOR CHEMICAL RESEARCH—The Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College, Gower Street, London, W.C.1 (April 17).

LECTURER IN GEOGRAPHY with special reference to Regional and Economic Geography—The Secretary, London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2 (April 18).

UNIVERSITY LECTURERS or UNIVERSITY DEMONSTRATORS in either THERMODYNAMICS or its applications, or in ELECTRICAL ENGINEERING—The Secretary, Appointments Committee, Engineering Laboratory, Cambridge (April 19).

LECTURER IN PHARMACOLOGY—The Secretary, University College, Gower Street, London, W.C.1 (April 20).

CHAIR OF ARCHÆOLOGY OF THE ANGLO-SAXON PERIOD at University College—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 21).

LECTURER IN PHYSICS—The Registrar, King's College, Strand, London, W.C.2 (April 22).

LECTURER IN BIOCHEMISTRY, and an ASSISTANT LECTURER IN PHYSIOLOGY—The Registrar, University College, Cathays Park, Cardiff (April 30).

POSTGRADUATE STUDENTSHIPS at a British University or research institute for research in the Colonial Empire in (*a*) Soil Science, (*b*) Insecticides, Fungicides and Herbicides, (*c*) Stored Products Entomology, (*d*) Fisheries—The Under-Secretary of State, Colonial Office (Research Department), Sanctuary Buildings, Great Smith Street, London, S.W.1 (April 30).

ASSISTANT LECTURER IN THE DEPARTMENT OF APPLIED MATHEMATICS—The Registrar, The University, Liverpool (May 1).

NUFFIELD STUDENTSHIPS and FELLOWSHIPS for experimental and theoretical research in Nuclear Physics—The Professor of Natural Philosophy, The University, Glasgow, W.2 (May 1).

RESEARCH POSTS IN APPLIED ECONOMICS—The Secretary, Oxford University Institute of Statistics, 91 Banbury Road, Oxford (May 1).

ASSISTANT DIRECTOR in the Commonwealth Bureau of Pastures and Field Crops, Aberystwyth—The Secretary, Commonwealth Agricultural Bureaux, 2 Queen Anne's Gate Buildings, Dartmouth Street, London, S.W.1 (May 1).

LECTURER IN GEOGRAPHY—The Secretary, Queen's University, Belfast (May 1).

READERSHIP IN GEOLOGY at Birkbeck College—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 2).

LECTURERS or ASSISTANT LECTURERS (4) IN THE DEPARTMENT OF PHYSICS—The Registrar, The University, Manchester 13 (May 8).

SENIOR LECTURER IN MECHANICAL ENGINEERING at the National School of Engineering, Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 8).

WELLCOME CHAIR OF CLINICAL TROPICAL MEDICINE at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 8).

BOTANISTS (2) to assist in the preparation of a Flora of Tropical East Africa, which is being undertaken by the Royal Botanic Gardens, Kew—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1.

CHIEF CHEMIST for new cement factory in Uganda—The Uganda Electricity Board, 129 Grand Buildings, Trafalgar Square, London, W.C.2.

CLINICAL PATHOLOGIST and LECTURER of consultant status in the Medical School—The Secretary, Charing Cross Hospital Medical School, 62–65 Chandos Place, London, W.C.2.

DESIGN ENGINEERS to design very large factories, including special equipment and plant and the layout required for efficient manufacturing processes—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

ECONOMIC BOTANIST—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

ELECTRICAL ENGINEER in the Marine Department, Nigeria—The Director of Recruitment (Colonial Service), Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27326/32.

EXPERIMENTAL OFFICER (male) to render skilled technical assistance (including photography) to resident and visiting research workers, to supervise the work of laboratory attendants, to prepare marine animals and plants for research and sales purposes—The Director, Marine Station, Millport, Isle of Cumbrae.

FUEL TECHNOLOGIST to carry out applied research in the Iron and Steel Industry—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting 'Fuel Technology'.

RESEARCH WORKER to take part in a programme of research in Tissue Culture—The Secretary, University College, Gower Street, London, W.C.1.

SYSTEMATIC FOREST BOTANIST in the Forest Department, Sierra Leone, for silvicultural supervision and research, preparation of a forest herbarium, co-ordination of records of utilization and silviculture, and ecological studies of forest flora—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

SCIENTISTS with chemical and/or botanical qualifications, for an investigation into the uptake of nuclear fission products by marine algæ—The Secretary, Scottish Seaweed Research Association, Inveresk Gate, Musselburgh, Midlothian.

SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS in various Government Departments and for a wide range of scientific research and development in most of the major fields of fundamental and applied science—The Secretary, Civil Service Commission (Scientific Branch), 7th Floor, Trinidad House, Old Burlington Street, London, W.1, quoting No. 2887.

STATISTICIAN (preferably with an honours degree in mathematics with special knowledge of statistics and statistical methods) in the Research Division of the Ministry of Agriculture, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Statistician'.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Selected Government Research Reports. Vol. 4: Textiles and their Testing. Pp. iv+86. (London: H.M. Stationery Office, 1949.) 6*s.* net. [1512

Bulletin of the British Museum (Natural History). Geology, Vol. 1, No. 1: The Pterobranch *Rhabdopleura* in the English Eocene. By Henry Dighton Thomas and Arthur George Davis; with an Appendix on the London Clay at Lower Swanwick, Hampshire, by Arthur Wrigley. Pp. 24+3 plates. 7*s.* 6*d.* Geology, Vol. 1, No. 2: A Reconsideration of the Galley Hill Skeleton. By K. P. Oakley and M. F. Ashley Montagu. Pp. 25–48+plate 4. 5*s.* (London: British Museum (Natural History), 1949.) [1512

Scientific Instrument Manufacturers' Association of Great Britain. List of Preferred Valves. Pp. 28. (London: Scientific Instrument Manufacturers' Association of Great Britain, 1949.) 2*s.* 6*d.* [1512

Other Countries

United States Department of the Interior: Geological Survey. Water-Supply Paper 1055: Surface Water Supply of the United States, 1946, Part 5, Hudson Bay and Upper Mississippi River Basin. Pp. xii+471. 1.25 dollars. Water-Supply Paper 1056: Surface Water Supply of the United States, 1946, Part 6, Missouri River Basin. Pp. xii+588. 1.50 dollars. Water-Supply Paper 1065: Surface Water Supply of Hawaii, 1945–46. Pp. vi+138. 40 cents. Water-Supply Paper 1074: Water Levels and Artesian Pressure in Observation Wells in the United States in 1946, Part 4, South-Central States. Pp. vi+215. 75 cents. (Washington, D.C.: Government Printing Office, 1949.) [1512